Crop Profile: Apples in New York

I. Profile Prepared By:

Eric Harrington/George Good
Cornell University/PMEP
5123 Comstock Hall
Ithaca, NY 14853
607-255-1866

II. Basic Commodity Information

State Rank: 2
% U.S. Production: 12%
Acres Planted:............................55,000
Pounds Harvested: ....1,070 million
Cash Value:................................$110 million
Yearly Production Costs: ....$
Production Regions: Eastern NY (Columbia, Dutchess, Ulster counties), Western NY (Niagara, Orleans, Oswego, Wayne counties) and the Champlain Valley.
Cultural Practices:
Commodity Destination(s):
Fresh Market 50%
Processing 50%

III. Pest Information

Key to Pests

AM = apple maggot; Aph = Spirea aphid and apple aphid; CM = codling moth; ECB= European corn borer; GFW = green fruitworm; OBLR = obliquebanded leafroller; PC = plum curculio; PLH = potato leafhopper; RAA = rosy apple aphid; RBLR = redbanded leafroller; STLM = spotted tentiform leafminer; TPB = tarnished plant bug; WALH = white apple leafhopper.

1. Apple Blotch Leafminer

Type of Pest: Insect
Frequency of Occurrence: Annually in eastern half of state
Damage Caused: Severe damage can cause fruit stunting or premature ripening, preharvest drop, or defoliation. Trees stressed by drought or other pests are more prone to these effects.
% Acres Affected: potential 100%; actual 10-15%. Primarily Hudson Valley.
Pest Life Cycles: There are three generations of leafminers per year. They overwinter as pupae in last year's leaves. The 1/4 inch long adults emerge and mate during half-inch green to pink. Eggs are laid in the evening on the underside of leaves. The eggs hatch in 5 to 16 days depending on the temperature. In the first three instars, the larvae form "sap-feeding" mines which appear as small silvery patches on the under surface of the leaf. In the last two instars, the larvae form "tissue-feeding" mines. These are characterized by the tent shape with spots appearing on the upper surface of the leaf.
Timing of Control: 1st--pink/petal fall; 2nd--early July; 3rd--mid August
Yield Losses: indirect pest; stresses tree's productivity, but not more than 5%
Regional Differences: doesn't occur in western New York
Cultural Control Practices:
Biological Control Practices: Several parasite and predator species suppress leafminer populations.
Post-Harvest Control Practices:
Other Issues: Insecticides are not effective against larvae once they have progressed to the tissue-feeding stage.

Chemical Controls for Apple Blotch Leafminer:

esfenvalerate (Asana XL 0.66EC)	20	Prebloom and cover	2-5.8 oz/100 gal	1st--pink/petal fall 2nd--early July 3rd--mid August	1 1 1	21	12
oxamyl (Vydate 2L)	10	Prebloom and cover	1 pt/100 gal	1st--pink/petal fall 2nd--early July 3rd--mid August	1 1 1	14	48
permethrin (Ambush 2EC)	2	Prebloom and cover	1.6-6.4 oz/100 gal	1st--pink/petal fall	1	PF	12

permethrin (Ambush 25WP)	1	Prebloom and cover	1.6-6.4 oz/100 gal	1st--pink/petal fall	1	PF	12
permethrin (Pounce 3.2EC)	2	Prebloom and cover	1-2 oz/100 gal	1st--pink/petal fall	1	PF	12
imidacloprid (Provado 1.6F)	60	Cover	2 oz/100 gal	1st--petal fall 2nd--early July 3rd--mid August	1 each	7	12
abamectin (AgriMek)	20	Cover	10 oz/Acre	PF-PF+14 days	1	28	12
methomyl (Lannate 2.4L)	5	Prebloom and cover	0.75 pt/100 gal	1st--pink 2nd--early July 3rd--mid August	1 each	14	72

PF=Petal Fall

2. Apple Maggot

Type of Pest: Insect
Frequency of Occurrence: Annually in potentially every block
Damage Caused: Signs of the infestation on the fruit are minute egg punctures in the skin and pitted areas on the surface. In late season varieties, the injury usually appears as corky spots or streaks on the flesh. In varieties ripening during July, August and September, open tunnels may occur. Rot producing organisms follow the maggots causing rapid decay of infested fruit.
% Acres Affected: potential 100%; actual <5%, >60% in Hudson Valley
Pest Life Cycles: The adult of the apple maggot is a black-bodied fly slightly smaller than the house fly. The female is larger than the male, and has four white bands across the abdomen while the male has only three. The wings of the fly are crossed by four dark bands. The adult flies emerge from their overwintering puparia (cocoon-like structures) in the ground during the latter half of June and continue to emerge through the middle of August. The flies require approximately 10 days after emergence to feed, mate and lay eggs. During this time they may be seen resting on the leaves or fruit of apples and other host plants lapping up drops of moisture with their fleshy mouth parts. The female has a sharp ovipositor with which she punctures the skin of the apple and inserts her minute whitish egg into the pulp of the fruit. A large number of eggs may be deposited in a single fruit, and fruits of the late varieties become dimpled and pitted as a result. The eggs hatch in 4 to 6 days; the young maggots begin at once to tunnel through the fruit, causing brown trails. Badly infested fruits often fall to the ground early. The numerous trails in the fruit reduce the inside of the apple to a brownish pulpy mass and render it unfit for consumption. The full grown maggot is about 3/8 inch long and is whitish or yellow white in color. The maggot emerges from the fallen fruit and burrows into the soil to a depth of 1 to 2 inches. Here it changes to a puparium, in which it overwinters. The following year the cycle starts again.
Timing of Control: As the eggs are inserted directly into the pulp beneath the skin of the fruit, and as the maggots never leave the apple until they are full-grown, it is impossible to kill them with any insecticide spray. Likewise, it is impossible to kill them with any spray applied to the soil as the adult flies may be migrating to the fruit trees from a hedgerow or abandoned fruit trees nearby. The adult flies, however, can be readily destroyed by having the fruit and leaves covered by an insecticide. As stated above, the flies do not begin to lay eggs until 10 days after emergence and during this time feed on moisture present on the fruit and foliage. For adequate protection against the apple maggot, control of the flies must be maintained from the last week in June through early September.
Yield Losses: <1%; if untreated, ~30% statewide
Regional Differences: higher population pressure in Hudson Valley
Cultural Control Practices: removal of wild hosts and abandoned apple trees
Biological Control Practices: insignificant
Post-Harvest Control Practices: NA
Other Issues: "Attract and Kill" may have potential, but probably not for commercial enterprises.

Chemical Controls for Apple Maggot:

azinphos-methyl (Guthion 50WP)	50	Cover	0.5 lb/100 gal	July and August	2-4	14	48
carbaryl (Sevin 50WP)	1	Cover	1.5 lb/100 gal	July and August	3-5	1	12
chlorpyrifos (Lorsban 50WS)	20	Cover	12 oz/100 gal	July and August	2-4	28	24

dimethoate (Dimethoate 4EC)	1	Cover	1 pt/100 gal	July and August	2-4	28	48
methomyl (Lannate 2.4L)	8	Cover	0.75 pt/100 gal	July and August	2-4	14	72
phosmet (Imidan 70WP)	20	Cover	0.75-1 lb/100 gal	July and August	2-4	7	24

3. Codling Moth

Type of Pest: Insect
Frequency of Occurrence: Annually in potentially every block
Damage Caused: CM larvae are fruit feeders and cause little or no injury to other plant parts. A larva may take a bite or two of a fruit causing an injury known as a "sting." Or, it may continue feeding, producing a deep entry into the fruit. A "sting" causes a surface blemish, but unlike a deep entry, it does not result in interior breakdown of the fruit. Fruit with "stings" from the first generation usually remain on the tree, while those with deep entries usually fall during the "June drop." Subsequent generations may or may not cause premature drop, depending on the variety. Second generation larvae are active in fruit throughout August. This later, deep entry damage is a more significant problem because affected fruit must be culled.
% Acres Affected: potential 100%; actual <5%
Pest Life Cycles: Adults: The spring flight of CM adults begins when apples are in bloom. In New York, second and third flights begin in early to mid-July and mid-August, respectively. Frequently, the second and third flights overlap, resulting in the presence of adults from early July through the remainder of the growing season. CM adults are 10-12 mm (0.5 in.) long, with a wing span of 15 to 20 mm (0.75 in). The moths are an iridescent gray color with a chocolate-brown patch, containing copper to gold markings, located at the tip of each forewing. The hind wings, which are not visible when the moth is at rest, are a lighter, copper brown color. During the day, CM adults remain at rest, well camouflaged, on the bark of trees. If the temperature is above 10-15.5°C (50-60°F) at dusk, the moths become active, mate, and the females lay their eggs. Under similar conditions, the moths can also be active at dawn. A female may lay up to 100 eggs.

CM eggs are laid singly, generally on the upper surface of leaves, or on the fruit. The eggs are flat, oval discs measuring 1.0 by 1.25 mm (0.04 by 0.05 in.). When first laid, an egg is translucent. It later develops a reddish embryonic ring; this is called the "red ring stage." Shortly before hatching, the dark head capsule of the developing larva can be seen; this is called the "black head stage. " Egg hatch occurs in 6-20 days depending on prevailing temperatures. First generation egg hatch begins at petal fall and continues for 2-3 weeks.

CM larvae go through 5 instars in 3-5 weeks. At egg hatch, larvae are about 2 mm (0.08 in.) long and white with a black head and thoracic and anal shields. Larvae are 13-19 mm (0.5-0.75 in.) long when fully grown. The body is pinkish white, while the head and thoracic and anal shields are brown. Newly hatched larvae seek fruit, which they enter to feed and develop. Entry may be through the calyx or the opposite side of the fruit. Larvae discard their first bites of epidermis, then either feed beneath the surface or tunnel directly to the center of the fruit. CM larvae deliberately feed on the seeds of the fruit. As larval development nears completion, they eat out an exit tunnel, which they plug with frass. Larvae leave the fruit and construct a thick silken cocoon under loose bark or in some other protected spot. The cocoon serves as a hibernaculum for the overwintering larva.

CM pupae are about 13 mm (0.5 in.) long and brown. The pupal period ranges from 7-30 days, depending on temperatures.
Timing of Control: Degree days (DD), calculated from base 50°F, are accumulated from the date of first sustained moth catch (the biofix). The first spray is applied at 250 DD50 after the biofix. This timing corresponds to a predicted 3% egg hatch. A second spray may be applied 10-14 days later. If pressure is not overly severe, one spray, applied at 360 DD50 after the biofix, is sufficient. A spray for the second generation should be applied 1260 DD50 after the biofix date. If CM pressure is severe, that application should be followed by another one in 10-14 days.
Yield Losses: <5%; if untreated losses would be 30-40%. General OP applications have made CM a secondary pest.
Regional Differences: Statewide
Cultural Control Practices: Mating disruption
Biological Control Practices: Predators and parasites feed on CM, but these natural enemies cannot keep this pest from reaching damaging levels in commercial orchards.
Post-Harvest Control Practices: NA
Other Issues: Few sprays are applied specifically against CM; controlled by applications against other pests (PC and AM). Loss of OP's would make this a significant pest of apples.

Chemical Controls for Codling Moth:

azinphos-methyl (Guthion 50WP)	50	Cover	0.5 lb/100 gal.	250-360 and 1260-1370 DD (base 50° F) after 1st moth catch	2-3	14	48

Bacillus thuringiensis (B.t.) (Dipel 2X 6.4WP)	1	Cover	2-8 oz/100 gal.	250-360 and 1260-1370 DD (base 50° F) after 1st moth catch	2-4	0	4
Bacillus thuringiensis (B.t.) (Dipel DF 10.3DF)	1	Cover	2-8 oz/100 gal.	250-360 and 1260-1370 DD (base 50° F) after 1st moth catch	2-4	0	4
Bacillus thuringiensis (B.t.) (MVP 0.9FM)	1	Cover	0.25-1.0 qt/100 gal	250-360 and 1260-1370 DD (base 50° F) after 1st moth catch	2-4	0	4
carbaryl (Sevin 50WP)*	1	Cover	1-2 lbs/100 gal.	250-360 and 1260-1370 DD (base 50° F) after 1st moth catch	2-3	1	12
chlorpyrifos (Lorsban 50WS)	20	Cover	12 oz/100 gal	250-360 and 1260-1370 DD (base 50° F) after 1st moth catch	2-3	28	24
dimethoate (Dimethoate 4EC)	2	Cover	1 pt/100 gal	250-360 and 1260-1370 DD (base 50° F) after 1st moth catch	2-3	28	48
methomyl (Lannate 2.4L)	5	Cover	1.5 pt/100 gal	250-360 and 1260-1370 DD (base 50° F) after 1st moth catch	2-3	14	72
phosmet (Imidan 70WP)	20	Cover	0.75 lb/100 gal	250-360 and 1260-1370 DD (base 50° F) after 1st moth catch	2-3	7	24

* If applied during thinning window, it may impact early part of 1st generation

4. Comstock Mealybug

Type of Pest: Insect
Frequency of Occurrence: sporadic
Damage Caused: The Comstock mealybug poses two major concerns for the apple processing industry of New York: First, the emergence of crawlers and adult females from the calyx of apples at the packinghouse creates a nuisance to workers. Second, apples to be made into puree typically are not peeled or cored by New York processors, so infestations can potentially result in unacceptable contamination of the product. Another problem, of concern to apple growers in the 1930s and 1940s, and again in the Hudson and Champlain valleys in the early 1980s, was that the honeydew secreted by the crawlers is a substrate for sooty molds growing on the fruit surface. This problem also occurs on peaches in Ontario, Canada. These molds result in a downgrading of the fruit, and are therefore an additional cause of economic loss.
% Acres Affected: <5%
Pest Life Cycles: The Comstock mealybug adult female is wingless and elongate-oval in shape, with a many-segmented body (2.5 to 5.5 mm long) and well-developed legs. It has 17 pairs of body filaments, with the caudal (posterior) pair being one-third as long as the body. The legs and antennae are inconspicuous. The body of the adult female is reddish-brown, but has a white appearance because it is covered with wax. Because of its small size and short life span, the adult male is very unlikely to be seen in the field unless it is captured in pheromone traps; even then it is difficult to distinguish without the aid of a microscope. It has a gnat-like appearance, with delicate, almost veinless wings, a light reddish-brown body (about 1 mm long), and two caudal filaments as long as or longer than the body. It is peculiar in having three pairs of eyes (dorsal, lateral, and ventral). The legs and 10-segmented antennae are apparent, but mouthparts are absent. There are two generations of Comstock mealybug in New York, each taking 60 to 90 days to complete, depending on seasonal temperatures. The egg is generally thought to be the primary overwintering stage, but recent evidence from western New York indicates that some nymphs and adult females from the second (summer) generation overwinter, with eggs being laid in the spring rather than the previous fall. Adult females and males emerge at the same time, from late June to mid-July for the first (overwintering) generation, and late August to mid-September for the second (summer) generation. Adult females are present for a total of four to six weeks, and oviposit for about one week after mating. Males survive for only a few days after emerging.

The eggs are elliptical (0.3 mm long and 0.17 mm wide) and bright orange-yellow (fig. 3), but may appear duller because of the waxy filaments covering them. Eggs are laid in jumbled masses along with the waxy filamentous secretions in protected places such as under bark crevices, near pruning cuts, and occasionally in the calyx of fruit. The summer generation eggs are laid from mid-June through late July, and the overwintering eggs from mid-August into October. The summer generation eggs have an incubation period of about 11 days.

The first and second larval instars of the female and male CMB are virtually indistinguishable. They appear similar to adult females except that they are smaller, more oval-shaped, lack the long body filaments, and are more orange-yellow because they have less wax covering. The first instar female crawler is flattened (0.3 to 0.5 mm long) and pale yellow, becoming darker in time. The second (0.9 to 1.2 mm long) and third (1.7 to 2.5 mm long) instar females are similar in appearance, but become progressively browner and redder. The third instar of the immature male, called a "pro-pupa," is contained in a cocoon that begins forming toward the end of the second instar. It is 0.9 to 1.2 mm long and elongate-oval, with the head, thorax, and abdomen fused. The fourth stage of the immature male is the pupa. It is elongate, 1.2 to 1.4 mm long, and light reddish-brown. As with the adult male, it has three pairs of eyes and 10-segmented antennae. The overwintered eggs hatch from mid-April through May and the nymphs (crawlers) migrate from the oviposition sites to their feeding sites on terminal growth and leaf undersides of trees and shrubs.

This hatch is completed by the petal fall stage of apples. Nymphs that hatch from these overwintered eggs are active from roughly early May to early July. As the nymphs approach the adult stage, they tend to congregate on older branches at a pruning scar, a node, or at a branch base, as well as inside the calyx of apples. Second generation nymphs are present from about mid-July to mid-September.
Timing of Control: Examine the terminal growth for crawler activity periodically throughout the summer. Crawler and adult female activity can also be monitored by wrapping black electrical or white carpet tape around scaffold branches and inspecting for crawlers that have been caught by the tape. They can be recognized with a hand lens or, with some experience, by the unaided eye.
Yield Losses: <5%
Regional Differences: More common but minimal problem in Hudson Valley
Cultural Control Practices:
Biological Control Practices:
Post-Harvest Control Practices:
Other Issues:

Chemical Controls for Comstock Mealybug:

chlorpyrifos (Lorsban 50WS)	95	Cover	12 oz/100 gal	Petal fall, Aug. 1 and Aug. 10	3	28	24
diazinon (DZN 50WP)	5	Cover	1 lb/100 gal	Petal fall, Aug. 1 and Aug. 10	3	21	24

5. Climbing Cutworms

Type of Pest: Insect
Frequency of Occurrence: rare
Damage Caused: Most injury from climbing cutworms occurs in the spring when they feed on fruit buds or blossoms. The larvae generally feed only on the lower central portion of the tree around the trunk, but under high population pressure, complete limbs or even whole trees may be stripped. Small trees are the most severely affected and abnormal growth can result from heavy defoliation several years in a row. Feeding by cutworms on the foliage or fruit during the fall or summer is rare, but may occur when the variegated cutworm is present.
% Acres Affected: <5%
Pest Life Cycles: The larvae of climbing cutworms are large, smooth caterpillars, measuring 1.2 to 1.6 inches (30 to 40 mm) when fully grown. The body has only a few hairs and the head capsule is usually brown or black; some have unusual markings on the head. Larvae of the different species vary in color with most species having a dull gray-brown background color with various species having stripes, spots, or marked with dark brown, black, yellow and white splotches. The dark brown pupae resemble those of leafrollers, but are much larger in size [i.e. >0.8 inch (20 mm)]. The adults are dark brown or grayish colored moths that look quite similar and have wingspans of about an inch (25 mm). The biology of the various climbing cutworms varies considerably. The most common species have one or two generations per year and overwinter as half-grown larvae on the soil in leaf litter and orchard debris. A few other species overwinter as eggs or even as adults. The species which overwinter as larvae begin to become active as the weather warms, generally in mid-April. This group of moths derives its name from the larval habit of climbing trees to feed on buds and young foliage during the night, and then crawling back down to the ground to seek shelter under leaf litter or debris on the orchard floor during the day. The larvae often curl up tightly when disturbed. Hundreds of larvae may feed on a single tree. The larvae mature by May and enter the soil to construct pupal chambers. In two-generation species, second generation feeding is minor. Adult emergence varies among species as shown above, but the most common species are on the wing from June through September. Eggs are laid on leaves, twigs, bark or even grasses. Newly hatched larvae of the single generation species seek low vegetation on which to feed until fall when they move to the ground seeking overwintering sites. Species with multiple generations per year generally overwinter as eggs.
Timing of Control: August, when observed.
Yield Losses: <1%
Regional Differences:
Cultural Control Practices: The best way to monitor is to check buds in the lower center of young trees for signs of first feeding early in the spring and to check the leaf litter around the base of the tree for overwintering larvae. Examine sites on the ground for rolled up larvae (under clods of earth, etc.). The larvae can only be observed feeding in the trees at night. Black light traps readily capture the adults, but because of the many host plant species and similar looking nonpest species, it is usually not an effective way to monitor.
Biological Control Practices:
Post-Harvest Control Practices:
Other Issues: So rare and sporadic that not enough sprays are applied to indicate a preference of materials.

Chemical Controls for Climbing Cutworms:

[redacted]							
B.t. (Biobit 1.6FC)		Cover	8-28 oz/100 gal	August	1-2	0	4
B.t. (Dipel 2X 6.4WP)		Cover	2-8 oz/100 gal	August	1-2	0	4
B.t. (Dipel 10.3 DF)		Cover	2-8 oz/100 gal	August	1-2	0	4
endosulfan (Thiodan 50WP)		Cover	1 lb/100 gal	August	1-2	21	24
methomyl (Lannate 2.4L)		Cover	0.75 pt/100 gal	August	1-2	14	72

6. Dogwood Borer

Type of Pest: Insect
Frequency of Occurrence: Annually in problem orchards
Damage Caused: Three general feeding types have been identified for the DWB on clonal apple rootstocks. Most frequently, feeding is confined to the burrknot. One or more larvae feed in irregular tunnels beneath the surface of the root initials. At first, feeding is quite shallow, but subsequent feeding may extend as far as 3/4-inch toward the center of the trunk. Feeding confined to the burrknot is believed to be least harmful to the tree. The second type of feeding may occur as a result of heavy or repeated infestation of a burrknot. As the burrknot tissue is consumed, the larvae move outward and begin to feed on the cambium adjacent to the burrknot (Type II). The third feeding type is not associated with a burrknot, but with bark scales and injured bark, and occurs infrequently (Type III). Feeding outside the burrknot is thought to be more harmful to the tree because healthy cambium tissue is destroyed. DWB nfestations can girdle and kill a tree, but more commonly contribute to a slow decline and yield reduction if they continue over a long period of time.
% Acres Affected: 40%
Pest Life Cycles: On apple, DWB larvae feed primarily in burrknot tissue on clonal rootstocks. Burrknots are aggregations of root initials which can develop on the above ground portion of the rootstock.

Adults: The DWB adult has a wing span of 18-22 mm. Both the fore and hind wings are mostly clear. The thorax and abdomen are deep blue-black with yellow markings. In the female, the entire 4th abdominal segment is yellow, while in the male it is black with a narrow yellow ring. In the Northeast, adult emergence begins in early June and continues into early September, peaking in mid-July.

Eggs: The eggs are light chestnut brown, oval, 0.6 by 0.4 mm, and are marked with a hexagonal pattern of slightly raised lines. Eggs are laid singly on the trunk, and hatch after an incubation period of 8-9 days.

Larvae: The larvae are off-white to cream colored with a reddish head capsule. Larvae pass through six instars ranging in length from 1 mm when newly hatched to 15 mm or more in the last instar. Soon after hatching, the larvae begin to burrow into the soft burrknot tissue, or areas under bark scales. As the larvae feed, reddish-brown frass is pushed to the surface, where it collects, held together by silk. Larvae overwinter in the feeding tunnel. Feeding resumes whenever the temperature is above 45-50°F (7-10°C). Larvae of the American plum borer (APB), Euzophera semifuneralis (Walker), have been found on apple in habitats similar to those preferred by the dogwood borer. The larvae of the two species are similar in size. However, the DWB larva is white to cream-colored, and has only one row of crochets on the abdominal prolegs, while the APB larva is dusky purple to gray in color, and has two rows of crochets on the prolegs.

Pupae: Pupation occurs in the feeding tunnel in a tough silken cocoon covered with bits of frass. The length of the pupal stage is variable, lasting from 8-20 days, depending on the temperature. Prior to emergence, the pupa pushes out of the cocoon and to the surface of the burrknot. The amber-colored pupal case often remains on the burrknot after the adult emerges.

Timing of Control: July to mid-August; applications are directed at young larvae and should coincide with egg laying.
Yield Losses: Indirect pest of considerable concern in NY at this time.
Regional Differences: Statewide
Cultural Control Practices: The best method of preventing DWB infestations on clonal rootstocks is to avoid burrknot development. Unfortunately, rootstocks without an inherent tendency to develop burrknots are not yet available. Burrknots found in the orchard were initiated in the stoolbed or the nursery, and their expression is influenced by environmental and cultural conditions in the orchard. Some agricultural chemicals with hormonal effects, such as naphthalene acetic acid, can increase the expression of burrknots. Roots will develop from burrknots if new plantings are set with the graft union close to ground level. In established plantings where the graft union is not too high above the ground, a wide cone of soil can be mounded around the exposed portion of the rootstock to accomplish the same

purpose. The cone of soil must be wide enough to prevent freezing injury to the buried rootstock. Where it is not possible to bury exposed rootstocks, the area around the trunk should be kept weed free to avoid shade and high humidity. Both of these conditions favor growth and development of burrknots initiated in the nursery. White latex paint brushed on the exposed portion of the rootstock before egg laying begins will prevent new infestations, and also protect against southwest injury to the bark.

Biological Control Practices: Several parasitoids and a fungal pathogen have been reported attacking the dogwood borer, but none provide appreciable control.

Post-Harvest Control Practices:

Other Issues: All commercial dwarfing and semi-dwarfing rootstocks have a tendency to develop burrknots.

Chemical Controls for Dogwood Borer:

chlorpyrifos (Lorsban 50WS)	80	Trunk	1.5 lb/100 gal	July 15-Aug. 15	1	28	24
endosulfan (Thiodan 50WP)	20	Trunk	1.5 lb/100 gal	July 1-5, Aug. 1-5	2	21	24

7. European Apple Sawfly

Type of Pest: Insect

Frequency of Occurrence: Annually in Eastern NY

Damage Caused: The first larval instar commences feeding just below the skin of the fruit, creating a spiral path usually around the calyx end. Should the fruit receive no further injury, this early larval feeding will persist as a scar that is very visible and objectionable at harvest. Following this feeding, the larva usually molts and begins tunneling toward the seed cavity of the fruit or an adjacent fruit. The larva's feeding to the core usually causes the fruit to abort. As the larva feeds internally, it enlarges its exit hole, which is made highly conspicuous by the mass of wet, reddish-brown frass, or insect excrement. The frass may drip on adjacent fruit and leaves, giving them a similarly unsightly appearance. The secondary feeding activity of a single sawfly larva can injure all the fruit in a cluster, causing stress on that fruit to abort or drop during the traditional "June drop" period.

% Acres Affected: 70% of Hudson Valley acreage

Pest Life Cycles: Adults: The European apple sawfly overwinters as a mature larva in a cocoon a few inches below the surface of the soil. The larva pupates early in the spring and emerges as an adult "fly" or wasp (fig. 1) about the time apple trees come into bloom. Adults are 6 to 8 mm in length, with the male smaller than the female. The head is yellow with yellow antennae and black eyes. The wings are covered with tiny black hairs, giving them a dusky appearance. The body is brown; the upper surface appears almost black and shiny and the lower surface lighter and orange to yellow. The males emerge first in the season, and as the season progresses both sexes can be found flying unsteadily about the blossoming apple trees. When they alight, they move rapidly around, quickly vibrating their antennae. The adults apparently feed on pollen and are most active when the sun is intense, usually around midday. The average adult life span is from one to two weeks.

Eggs: The female sawfly lays her eggs in apple blossoms, often at the base of the stamens. She inserts her ovipositor (the saws) through the sepal. The insertion and withdrawal of the ovipositor often leaves a brownish discoloration on the sepal or receptacle, which helps in detecting infested blossoms. The egg is about 0.8 mm in length, oval, colorless, and shiny. The eggs hatch within one to two weeks depending on daily temperatures.

Larvae: The larva measures about 1.7 mm in length at hatch. It is light cream colored with a black head and caudal (rear) shield. The head and shield become lighter as the larva matures until they are pale brown in the mature fifth-instar stage. The larva increases in size by approximately 1.4 times during each instar so that when mature it is 9 to 11 mm long. The codling moth and similar lepidopterous larvae (e.g., the lesser appleworm), which may be feeding on the apple fruit at the same time as the sawfly, may be distinguished from the sawfly larvae by the number of prolegs on the abdomen. Prolegs are the fleshy, stump-like appendages that extend beneath the abdomen behind the three slender pairs of true legs. There are seven pairs of prolegs on sawfly larvae but only five pairs on the larvae of the lepidopterous pests. When mature, the sawfly larvae leave the fruit, enter the soil, and construct cocoons in which they remain as pupae until the following spring. The cocoons are egg-shaped, parchmentlike brown cases usually 4 by 8 mm in size. The appendages of the pupae are not glued to the body, and they resemble mummified adults.

Timing of Control: The time of insecticide application usually determines the extent of sawfly injury; for example, a late application, after petals fall, will often kill developing sawfly larvae in the early tunneling stage so that tunneling scars will be short and indistinguishable from damage caused by the tarnished plant bug.

Yield Losses: <10%

Regional Differences: The pest is especially troublesome in the Hudson Valley of New York.

Cultural Control Practices: None

Biological Control Practices: None

Post-Harvest Control Practices: None

Other Issues: Pest only in Southeastern NY.

Chemical Controls for European Apple Sawfly:

chlorpyrifos (Lorsban 50WS)	10	Post-bloom	12 oz/100 gal	Petal fall	1	28	24
phosmet (Imidan 70WP)	25	Post-bloom	0.75-1 lb/100 gal	Petal fall	1	7	24
azinphos-methyl (Guthion 50WP)	65	Post-bloom	0.5 lb/100 gal	Petal fall	1	14	48

8. European Corn Borer

Type of Pest: Insect
Frequency of Occurrence: Annually in problem orchards
Damage Caused: ECB larvae sometimes tunnel in current year's shoots, causing them to wilt. The caterpillars, which are light colored with a dark brown head, have also occasionally been found in the fruit. Typically this occurs on lower limbs near groundcover, and in blocks near cornfields.
% Acres Affected: 10-20%
Pest Life Cycles: The female moth has a robust body and a wingspread of about 25.5 mm. It is pale yellow to light brown. The outer third of the wings is usually crossed by two dark, zigzag lines. The male moth is smaller, more slender, and darker than the female. The outer third of its wings is usually crossed by two zigzag streaks of pale yellow, and often there are pale yellow areas on forewings.

Each white egg is about half the size of a pinhead. It changes to pale yellow and darkens just before hatching as the brown head of the borer inside becomes visible. The eggs overlay each other like fish scales.

The newly hatched larva, about 1.5 mm long, has a black head, five pairs of prolegs, and a pale yellow body bearing several rows of small black or brown spots. It develops through five or six instars to become a full-grown larva about 25.5 mm long.

The brown pupa is 13 to 15 mm long with a smooth, capsule-like body. Mature larvae overwinter inside tunnels in stubble, stalks, or other protective plant material. They pupate in the spring. During late spring, the adult moths emerge and mate. Each female lays 500 to 600 eggs in small masses of 15 to 20 on the underside of leaves. Eggs hatch in 3 to 12 days, depending upon the temperature. The young larvae usually begin feeding on the leaf surface and, as they mature, begin boring in the midribs of the leaves. During the 4th instar, boring commences and continues until pupation.

Timing of Control: June; August when insects or damage noted
Yield Losses: <5%
Regional Differences: mostly Hudson Valley
Cultural Control Practices: Keeping groundcover mowed helps prevent damage.
Biological Control Practices: Many natural parasites of this corn borer, mainly flies and wasps which have been introduced from Europe, exist in areas. Other biological control agents such as ladybird beetles, predaceous mites, and downy woodpeckers have also been responsible for some borer reduction. The bacterium Bacillus thuringiensis, however, shows most promise for borer control.
Post-Harvest Control Practices: NA
Other Issues: Damage occurs rarely. Usually, regular cover sprays of OP's minimize damage.

Chemical Controls for European Corn Borer*:

chlorpyrifos (Lorsban 50WS)	80	Cover	8-12 oz/100 gal	mid-June; August	2-4	28	24
methomyl (Lannate 2.4L)	20	Cover	0.75 pt/100 gal	mid-June; August	2-4	14	72

*Specific sprays for ECB are extremely rare

9. European Fruit Lecanium

Type of Pest: Insect
Frequency of Occurrence: rare
Damage Caused: These scale species tend to be less injurious than SJS. Where infestation is severe, twig and limb death may occur as feeding scale remove sap from the tree. A more common problem is the discoloration of fruit and leaves from a black sooty mold which grows on the honeydew produced by feeding scale.

% Acres Affected: <5%
Pest Life Cycles: These species are known as soft or unarmored scales since the protective covering is a thickened part of the insect's body rather than a separate structure. Adult female scales are dark reddish-brown, often with black mottling and banding radiating down the sides. They have a very convex hemispherical shape, with a crimped margin. The European fruit lecanium is slightly larger than 1/10 inch (2 mm) in diameter. Adult male scales are tiny 2-winged insects. Eggs of the European fruit lecanium are white, and crawlers of both species are light colored. Immature female scales overwinter on the bark of twigs and limbs, usually being more abundant on the underside. They resume feeding in the spring and mature during May. During June the European fruit lecanium produces eggs which hatch into crawlers. Crawlers migrate to the underside of foliage to feed for about one month. Female scales return to the bark of twigs and limbs to continue feeding, whereas males usually mature on foliage and emerge to mate with females. There are one or two generations of the European fruit lecanium per year.
Timing of Control:
Yield Losses: <1%
Regional Differences:
Cultural Control Practices: In general, controls will be more effective if the scale population on a plant is first physically reduced by pruning out heavily infested and sickly branches. In some cases, large sized scales can be scrubbed off with a stiff brush.
Biological Control Practices:
Post-Harvest Control Practices:
Other Issues: Incidental control from sprays against mites. Very minor pest; could become important as growers cease to use dormant oil for ERM.

Chemical Controls for European Fruit Lecanium:

oil	100	Pre-bloom	2-3 gal/100 gal	Silver tip	1	0	12
oil	20	Cover	2-3 gal/100 gal	Dormant to pink	1-2	NA	12

10. Green Fruitworms

Type of Pest: Insect
Frequency of Occurrence: Sporadic
Damage Caused: Most flower buds and blossoms damaged by GFW larvae abort. Most fruit damaged just prior to and shortly after petal fall also drop prematurely. Some, however, remain at harvest and exhibit deep corky scars and indentations. This injury is indistinguishable at harvest from that caused by the overwintering larvae of the obliquebanded leafroller.
% Acres Affected: <10%; as high as 30% in Hudson Valley
Pest Life Cycles: Adults: GFW adults are night fliers. Their flight closely parallels apple bud development. It begins at about green tip, peaks at tight cluster, and is completed by the pink stage. GFW adults are about 16 mm in length. The forewings are grayish pink; each is marked near the middle with 2 purplish gray spots, outlined by a narrow pale border. The hindwings, which are not visible when the moth is at rest, are slightly lighter in color than the forewings. Females begin egg laying on twigs and developing leaves when apples are in the half-inch green stage. A female is capable of laying several hundred eggs, but normally deposits only 1 or 2 at any given site.

Eggs: GFW eggs are about 0.8 mm in diameter and 0.5 mm in height. Freshly laid GFW eggs are white with a grayish tinge and have numerous ridges radiating from the center. Shortly before hatching, the egg takes on a mottled appearance.

Larvae: GFW larvae pass through 6 instars. Newly hatched larvae are 2-3 mm in length and have a grayish green body with a brown head and thoracic shield. Mature larvae are 30-40 mm in length and have a light green body and head. Several narrow white stripes run longitudinally along the top of the body and a slightly wider, more distinct white line runs along each side. The green areas between the stripes are covered with numerous white speckles. Young larvae feed on new leaves and flower buds and can often be found inside a rolled leaf or bud cluster. Older larvae damage flower clusters during bloom and continue to feed on developing fruit and leaves for 1-2 weeks after petal fall. They then drop to the ground, burrow 50-100 cm beneath the soil surface, and pupate.

Pupae: The GFW overwinters 50-100 mm (2-4 in) underground in the pupal stage. The pupae are dark brown and about 16 mm in length.
Timing of Control: : Since feeding activity begins before bloom, insecticides may be required when buds develop 1/2 inch of new growth (green tissue) and again at petal fall. Fruitworms are usually kept under control with sprays targeting other insect pests on apples.
Yield Losses: <5%
Regional Differences: This pest can sometimes be serious in Hudson Valley; and can sometimes be severe in

Champlain Valley.
Cultural Control Practices:
Biological Control Practices: None
Post-Harvest Control Practices:
Other Issues:

Chemical Controls for Green Fruitworms:

chlorpyrifos (Lorsban 50WS)	40	Post-bloom	12 oz/100 gal	Petal fall	1	28	24
endosulfan (Thiodan 50WP)	40	Pre-bloom	1 lb/100 gal	Pink	1	21	24
endosulfan (Thiodan 3EC)	10	Pre-bloom	2/3 qt/100 gal	Pink	1	21	24
esfenvalerate (Asana XL 0.66EC)	2	Post-bloom	2-5.8 oz/100 gal	Petal fall	1	21	12
methomyl (Lannate 2.4L)	2	Post-bloom	0.75 pt/100 gal	Petal fall	1	14	72
permethrin (Ambush 2EC)	1	Post-bloom	1.6-6.4 oz/100 gal	Petal fall	1	PF	12
permethrin (Ambush 25WP)	1	Post-bloom	1.6-6.4 oz/100 gal	Petal fall	1	PF	12
permethrin (Pounce 3.2EC)	2	Post-bloom	1-2 oz/100 gal	Petal fall	1	PF	12
permethrin (Pounce 25WP)	2	Post-bloom	1.6-3.2 oz/100 gal	Petal fall	1	PF	12

11. Lesser Appleworm

Type of Pest: Insect
Frequency of Occurrence: rare
Damage Caused: LAW larvae feed primarily on the fruit at either the calyx or stem ends. Only rarely are the larvae found feeding on the side of the apple. Feeding on the fruit is shallow [<0.24 inch (6 mm) deep] and the injury is in the form of a blotchy mine similar in shape to the feeding injury caused by the redbanded leafroller. RBLR, however, consume the skin when they feed, but the LAW larvae feed just below the apple skin and do not consume it. There will often be an inconspicuous pile of frass near the feeding site that is characteristic of LAW feeding. Damage from the OFM is much deeper and similar to damage associated with the CM. Conspicuous dark brown frass around the entrance hole is often associated with OFM injury and the larvae will often enter the side of the apple as well as the ends of the apple fruit. Fruit infested during the first generation of LAW generally fall to the ground during June drop, but fruit infested during the second generation will often contain larvae at harvest.
% Acres Affected: <1%
Pest Life Cycles: The adults are approximately 0.28 inch (7 mm) long and have a wingspan of about 0.43 inch (11 mm). The adults are smaller than the closely related oriental fruit moth and cherry fruitworm. The front wings are dark brown in color with scattered patterns of grayish orange patches and a few thin transverse bands of shining pale blue. The two largest gold areas are found in the middle of the front wing and on top of the head. When the wings are folded in the resting position, these areas form a gold band stretching across the back. The female moth lays between 40-60 eggs. The eggs are flat oval disks 0.025 x 0.022 inch (0.65 x 0.55 mm) in size. When first laid, the eggs are white, but soon turn a yellowish color. The larvae reach a length of 0.35 inch (9 mm) with a head capsule width of 0.032 inch (0.8 mm) In size and coloring, the larvae are almost indistinguishable from those of the cherry fruitworm and oriental fruit moth (OFM). All three of these species have an anal comb which separates them from codling moth larvae, all are white with reddish-pink tinges, and all have a dark brown head capsule and thoracic shield. The oriental fruit moth tends to be paler in coloration than the other two species but methods suggested in the literature to separate the species by boiling or preserving in special fluids do not always work. The only sure method to distinguish these three species from each other is to rear them to adulthood or note the type of damage they do. The larvae pupate in tightly woven white cocoons and the golden brown pupae are about 0.20 inch (5 mm) in length. The biology of the LAW is very similar to that of the CM with adult emergence of each species occurring within a week of each other during both generations. Both species overwinter as full grown larvae in hibernacula in cracks and crevices on the tree trunk, or in the leaf litter below the tree, or occasionally in the calyx end of fallen fruit. The larvae pupate within the hibernacula early in the spring, generally during May, and begin adult emergence 2-3 weeks later with peak emergence by mid-June. The eggs are laid singly on the upper surface of leaves or directly on the young fruit. Upon

hatching, the young larvae immediately search for a fruit on which to feed and begin mining the fruit just beneath the skin, generally near the calyx end. Deep internal feeding by LAW larvae in apple fruit is rare and many reports of this type of injury associated with this moth are due to confusion of their larvae with the very similar OFM larvae. The larvae of the first generation have been reported to bore into the young shoots of apple to feed in the same manner as oriental fruit moth, but this is rare. The first generation larvae complete development by mid- to late-July and may or may not leave the fruit to pupate. The first adults of the second generation begin to emerge by early August and peak emergence generally occurs by mid-August. Adult flight from this generation, however, may continue into October. Larvae of the second generation are often present at harvest and begin to form hibernacula in October.

Timing of Control: Petal fall
Yield Losses: <1%
Regional Differences:
Cultural Control Practices:
Biological Control Practices:
Post-Harvest Control Practices:
Other Issues: incidental control from petal fall sprays against CM and OFM

Chemical Controls for Lesser Appleworm:

azinphos-methyl (Guthion 50WP)	50	Post-bloom	0.5 lb/100 gal	Petal fall	1	14	48
B.t. (Dipel 2X 6.4WP)	1	Post-bloom	2-8 oz/100 gal	Petal fall	1	0	4
B.t. (Dipel 10.3DF)	1	Post-bloom	2-8 oz/100 gal	Petal fall	1	0	4
B.t. (MVP 0.9FM)	1	Post-bloom	0.25-1 qt/100 gal	Petal fall	1	0	4
carbaryl (Sevin 50WP)	1	Post-bloom	1-2 lb/100 gal	Petal fall	1	1	12
chlorpyrifos (Lorsban 50WS)	20	Post-bloom	12 oz/100 gal	Petal fall	1	28	24
dimethoate (Dimethoate 4EC)	1	Post-bloom	1 pt/100 gal	Petal fall	1	28	48
methomyl (Lannate 2.4L)	5	Post-bloom	1.5 pt/100 gal	Petal fall	1	14	72
phosmet (Imidan 70WP)	20	Post-bloom	0.75 lb/100 gal	Petal fall	1	7	24

12. Obliquebanded Leafroller

Type of Pest: Insect
Frequency of Occurrence: Annually in problem orchards
Damage Caused: The most serious injury from overwintering OBLR larvae occurs just prior to and shortly after petal fall, when the developing fruit is damaged. Many of these damaged fruits drop prematurely, but a small percentage remain on the tree, exhibiting deep corky scars and indentations at harvest. Leaf injury by all broods is characterized by the larvae rolling leaves and feeding on surrounding foliage. The first summer brood larvae feed on the surface of developing fruit in late July and early August. This injury is similar to that caused by several other species of leafrollers. Fruit damage caused by first summer brood OBLR larvae is usually more serious than spring feeding by overwintered larvae because more of the fruit injured later in the season remains on the tree at harvest.
% Acres Affected: 25-50%
Pest Life Cycles: The spring flight of OBLR adults begins about 3-4 weeks after petal fall on apples, and continues for 3-4 weeks. In areas where the OBLR has 2 generations, a second flight occurs from early August through early September. OBLR adults are 9-12 mm in length and have a wingspan of 20-27 mm. The forewings are reddish- brown and crossed by 3 oblique, chocolate-brown bands. The hind wings, which are not visible when the moth is at rest, are pale yellow. After emergence, females have a 24 hour preoviposition period. They then begin laying egg masses that gradually diminish in size with each succeeding egg mass laid. A female is capable of laying up to 900 eggs during her 78 day oviposition period.

Eggs: OBLR eggs are laid on the upper surface of leaves. They appear as greenish yellow masses measuring about 5 x 9 mm and may contain 200 or more eggs. The black head capsules of embryonic larvae become visible prior to hatching which usually occurs in 10-12 days.

Larvae: OBLR larvae are indiscriminate feeders that pass through 6 instars. Newly hatched larvae have a yellowish green body and a black head and thoracic shield. Mature larvae are 20-25 mm in length and the head and thoracic shield may be either black or various shades of brown. The first summer brood of larvae emerge in early July and complete their development in late July or early August. Second brood larvae begin to emerge in mid-August, and feed until they reach the third instar in the fall, when they construct hibernation sites on twigs or bark and enter winter diapause. These overwintering larvae resume activity the following spring when the tree breaks dormancy and complete their development about 3 weeks after the apple blossom period. Overwintered OBLR larvae (spring brood) first feed on water sprouts and then move throughout the tree. Those feeding on developing flower buds do so before bloom and continue to consume floral parts throughout the blossom period. After petal fall, these larvae continue feeding on the developing fruit. Newly hatched larvae of the first summer brood move to and feed on tender growing terminals, water sprouts, or developing fruit. As these larvae reach the third instar they display an increasing propensity to damage fruit. The second brood larvae, which develop in late summer and fall, feed primarily on leaves until they enter diapause, although they may occasionally damage fruit.

Pupae: OBLR pupae are dark brown, about 11 mm in length, and are usually found in rolled leaves on the tree.

Timing of Control: Insecticides must be applied at petal fall. If necessary, another spray should be applied in the summer. An alternative strategy is to control overwintering larvae at petal fall as previously described, and apply sprays during June to kill the first summer brood adults and newly hatching larvae. Conventional organophosphate insecticides are used in this program. The flight of adults are monitored with pheromone traps. The first spray should be applied about 7 days after the first male moth is captured and subsequent sprays should be applied at 14-day intervals as long as the flight continues.

Yield Losses: 3-30%

Regional Differences: Most severe in Western NY; but areas of Hudson and Champlain Valleys have increasing infestations.

Cultural Control Practices:

Biological Control Practices: Several parasites attack OBLR larvae but do not adequately control the pest.

Post-Harvest Control Practices: NA

Other Issues:

Chemical Controls for Obliquebanded Leafroller:

B.t. *(Dipel 2X 6.4WP)*	20	Cover	2-8 oz/100 gal	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-4	0	4
B.t. *(Dipel 10.3DF)*	8	Cover	2-8 oz/100 gal	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-4	0	4
B.t. *(Biobit 1.6FC)*	1	Cover	8-28 oz/100 gal.	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-4	0	4
B.t. *(MVP 0.9FM)*	1	Cover	0.25-1 qt/100 gal	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-4	0	4
B.t. *(Agree WG 3.8WS)*	1	Cover	0.25-0.5 lb/100 gal.	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-4	0	4
chlorpyrifos *(Lorsban 50WS)*	40	Cover	12 oz/100 gal	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-4	28	24
methomyl *(Lannate 2.4L)*	5	Cover	0.75 pt/100 gal	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-3	14	72
permethrin *(Ambush 2EC)*	1	Cover	1.6-6.4 oz/100 gal	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-3	PF	12
permethrin *(Ambush 25WP)*	1	Cover	1.6-6.4 oz/100 gal	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-3	PF	12
permethrin *(Pounce 3.2EC)*	1	Cover	1-2 oz/100 gal	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-3	PF	12
permethrin *(Pounce 25WP)*	1	Cover	1.6-3.2 oz/100 gal	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-3	PF	12
spinosad *(SpinTor 2SC)*	10	Cover	2.5 oz/100 gal	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-3	7	4
esfenvalerate *(Asana XL)*	30	Cover	2-5.8 oz/100 gal	Petal fall and starting 360 DD (base 43° F) after 1st moth catch	2-3	21	12

13. Oriental Fruit Moth

Type of Pest: Insect

Frequency of Occurrence: Annually in problem orchards

Damage Caused: The OFM feeds in both vegetative growth and fruit. The first generation, which is feeding when terminals are succulent and tender, develops almost exclusively in the vegetative growth. The larvae often enter the terminal at the base of a young leaf, and tunnel toward the base of the shoot. Infested terminals wilt and die back to the margin of feeding, and are commonly called "strikes" or "flagged shoots." Heavy twig infestations of nursery stock can adversely affect the shape of the tree. Axillary buds often begin to grow when the terminal shoot is killed, causing the tree to have a bushy appearance.

Infested apples have a collection of frass at the exit hole of the insect's feeding tunnel, or at the calyx end. It is difficult to distinguish between OFM damage and codling moth damage. OFM larvae feed randomly in the apple, and usually do not feed on the seeds, while codling moth larvae usually tunnel directly to the core of the apple and feed on the seeds. Later instar larvae of the two species may be distinguished by the presence or absence of the anal comb at the tip of the abdomen. The anal comb is present in the OFM and absent in the codling moth.

% Acres Affected: potential 100%; actual 10%

Pest Life Cycles: Adult: The adult OFM is a small, grayish moth with a wingspan of approximately 13 mm (0.5 in.). Adults of the overwintering generation begin to emerge about the time of apple bloom, and females begin to lay eggs after a two- to five- day pre-oviposition period. Each female can lay up to 200 eggs during her seven- to ten-day oviposition period.

Eggs are found on upper leaf surfaces, frequently on the terminal leaf of a young shoot. Each egg is slightly oval, measuring 0.6 x 0.7 mm (.02 x .03 in.). It is translucent white when first laid, changing later to an amber color. The incubation period varies with temperature, ranging from three to four days at midsummer, to seven to fourteen days during the cooler part of the season. Just before the larva hatches, the dark head capsule can be seen through the egg. This is known as the "black head" stage.

Shortly after hatching, larvae enter young terminals or fruit and begin to feed. The larvae pass through four to five instars, and range in length from 1.5 mm (.06 in.) when newly hatched to approximately 12 mm (.5 in.) when mature. Newly hatched larvae are white, with a black head capsule. Mature larvae are dirty white to pink in color, with a reddish brown head capsule. If a terminal becomes unsuitable as a food source before larval development is complete, larvae seek other terminals, or move to fruit to complete their development. Mature larvae leave their feeding sites to spin cocoons in which they either pupate, or enter diapause to overwinter. Diapause is a resting period that allows many species of insects to suspend development until weather conditions become favorable. In the OFM, diapause is induced by decreasing day length in late summer.

Pupae are found within cocoons on the trunk (usually within two feet of the ground) or in debris on the ground under the tree. The cocoons are constructed of silk, and are covered with particles of the surface on which they are spun. Early in the season, nearly all of the larvae pupate soon after spinning a cocoon. The pupal stage lasts from twelve to fifteen days in the summer, and somewhat longer at cooler temperatures during the spring. Later in the season, as day length decreases, an increasing proportion of larvae enter diapause to overwinter. Diapausing larvae pupate and emerge the following spring.

Timing of Control: Petal fall and mid-summer

Yield Losses: <10%

Regional Differences: Not as problematic in Champlain Valley as in other areas

Cultural Control Practices: adjacent peach orchards often are infestation sources

Biological Control Practices: More than 130 species of parasitoids have been reported attacking OFM; however, parasitism probably plays a very minor role in OFM control in today's commercial orchards because of the sensitivity of many parasitoids to commonly used insecticides. Before the advent of DDT, attempts were made to supplement naturally occurring biological control of the OFM. Inundative releases of the braconid wasp Macrocentrus ancilivorus provided an average 50% reduction in number of infested fruit. However, because of the large pest complex on apple, biological control of one pest is difficult to achieve, since broad-spectrum insecticides are still needed for other pests. Research has shown that if a synthetic sex pheromone is released in high concentrations in an orchard, male Oriental fruit moths cannot locate a female to mate. This control method, known as mating disruption, has proven effective in field tests.

Post-Harvest Control Practices:

Other Issues: The OFM is rarely a problem in orchards with a regular insecticide program, but could become a more important pest as patterns of insecticide use change, or if insecticide resistance develops. May be more serious in areas of stone fruit production.

Chemical Controls for Oriental Fruit Moth:

azinphos-methyl (Guthion 50WP)	50	Cover	0.5 lb/100 gal	Petal fall and mid-summer	2-3	7	48
B.t. (Dipel 2X 6.4WP)	1	Cover	2-8 oz/100 gal	Petal fall and mid-summer	2-3	0	4
B.t. (Dipel 10.3DF)	1	Cover	2-8 oz/100 gal	Petal fall and mid-summer	2-3	0	4

B.t. (*MVP 0.9FM*)	1	Cover	0.25-1 qt/100 gal	Petal fall and mid-summer	2-3	0	4
carbaryl (*Sevin 50WP*)	1	Cover	1-2 lb/100 gal	Petal fall and mid-summer	2-3	1	12
chlorpyrifos (*Lorsban 50WS*)	20	Cover	12 oz/100 gal	Petal fall and mid-summer	2-3	28	24
dimethoate (*Dimethoate 4EC*)	2	Cover	1 pt/100 gal	Petal fall and mid-summer	2-3	28	48
methomyl (*Lannate 2.4L*)	5	Cover	1.5 pt/100 gal	Petal fall and mid-summer	2-3	14	72
phosmet (*Imidan 70WP*)	20	Cover		Petal fall and mid-summer	2-3	7	24

14. Oystershell Scale

Type of Pest: Insect
Frequency of Occurrence: rare
Damage Caused: Bark become cracked and scaly, trees lose vigor, foliage is dwarfed and spotted with yellow.
% Acres Affected: <5%
Pest Life Cycles: Scale cover resembles small oyster shell. The adults are usually clustered together and in severe infestations may cover the bark of infested branches completely. Eggs are laid in late fall, 40-150 per female. Hatching occurs in late spring. Crawlers move around 1-2 hours to 1-2 days before settling. The scales are white in color at first but become brown with maturity. They mature about the middle of July, mate, and lay eggs. This second generation develops and by late fall they lay the eggs which overwinter for the spring generation.
Timing of Control: Sprays should be applied at time of crawler hatch and emergence from the old females, in mid-to-late May and again in late July or early August.
Yield Losses: <1%
Regional Differences:
Cultural Control Practices:
Biological Control Practices:
Post-Harvest Control Practices:
Other Issues: Occurs rarely; populations suppressed by cover sprays for other insects.

Chemical Controls for Oystershell Scale:

azinphos-methyl (*Guthion 50WP*)	80	Post-bloom	1-2 lb/100 gal	Petal fall and first cover	2	14	48
carbaryl (*Sevin 80WS*)	20	Post-bloom	0.3-0.9 lb/100 gal	Petal fall and first cover	2	1	12
Oil	5	Cover	1-2%	Petal fall through harvest	1-2	0	12

15. Plum Curculio

Type of Pest: Insect
Frequency of Occurrence: Most commercial orchards are free of resident populations and are infested by adults moving in from hedgerows and woodlands. Injury is therefore heaviest close to these sites.
Damage Caused: The adults can injure the fruit in two ways during the early season: 1) feeding injury and 2) egg laying (oviposition) injury. Feeding punctures consist of small, round holes extending 1/8 inch (3 mm) into the fruit; egg punctures are distinguished by a characteristic crescent-shaped cut that partly surrounds the sunken egg. As the fruit matures both types of injury become corky in appearance. Slight feeding may occur on petals, buds, and blossoms, but there is little injury until the fruit is available. Early-blooming varieties are the first to provide suitable locations for feeding and egg laying. During the egg laying period, the female PC initially eats a small hole in the fruit, deposits an egg, and then makes a crescent-shaped slit just below the site with her snout. It is believed that the slit relieves pressure from the rapidly growing fruit and helps the hatching larva to become established. Egg laying scars appear on fruit at harvest as crescent-shaped corky areas resembling the letter "D." Adults which successfully emerge in mid-summer can again feed on fruit. This injury appears as small, soft, irregular holes, usually near the calyx of the fruit. The injury usually occurs in orchards that have high amounts of egg laying injury. Adults can average over 100 feeding and/or egg punctures during their normal life.
% Acres Affected: potential 100%; actual <5%
Pest Life Cycles: The biology of PC is similar for most deciduous fruits, although the timing may be slightly different. The adults overwinter in the top few inches of leaf litter in nearby hedgerows, trashy fields and woods (especially on

the south edge of an orchard). The adults initially appear in apple orchards during bloom. Most beetle activity occurs during the first warm period after petal fall, when the maximum temperature is 70°F or higher. Periods of cool, rainy weather with maximum temperatures below 70°F are not suitable for adult activity. Adults can be found in orchards for 5 to 7 weeks. Egg laying activity starts once the fruit begins to form, with egg hatch occurring after 7 days. In successfully attacked hosts, the hatching larva burrows into the fruit's center, where it makes large irregular cavities. Fruit that are successfully attacked by larvae are prone to drop prematurely. After 14-16 days within the fruit the larvae exit and enter the soil where they form a pupation chamber for an additional 10-12 days before transforming into adults. New adults can appear in the orchards in mid- to late- July with emergence continuing until early September. In September and October adults begin seeking overwintering quarters.
Timing of Control: In the spring, control can be obtained with 1-3 insecticide applications, depending on the spray timing and severity of the problem. The first spray should be applied at about petal fall.
Yield Losses: <5%; if untreated, could be >60% in some areas
Regional Differences: Hudson Valley more so than Western NY, which is more so than Champlain Valley
Cultural Control Practices: Concentrate on border rows near hedgerow
Biological Control Practices: None
Post-Harvest Control Practices: None
Other Issues: NA

Chemical Controls for Plum Curculio:

azinphos-methyl (Guthion 50WP)	50	Postbloom and Cover	0.5 lb/100 gal	Petal fall and 10-14 days later	2	14	48
carbaryl (Sevin 50WP)	10	Postbloom and Cover	2 lb/100 gal.	Petal fall and 10-14 days later	2	1	12
chlorpyrifos (Lorsban 50WS)	20	Postbloom and Cover	12 oz/100 gal	Petal fall and 10-14 days later	2	28	24
phosmet (Imidan 70WP)	20	Postbloom and Cover	0.75-1 lb/100 gal.	Petal fall and 10-14 days later	2	7	24

16. Potato Leafhopper

Type of Pest: Insect
Frequency of Occurrence: Sporadically heavy, depending on weather patterns
Damage Caused: The cellular injury caused to the leaf of the various food plants causes a typical "hopperburn." Unlike WLH, PLH prefers young leaves, and consequently is a greater problem on young trees, which have a greater proportion of young leaves on each tree, and continue growing longer into the season. Invasion and resulting damage can occur quickly. The edges of the leaf curl downward, first turning lighter green, then yellow, and finally brown and necrotic. On young trees this may be sufficient to stop growth of the tree. If these leafhoppers are controlled, growth may resume later in the season.
% Acres Affected: 10-40%
Pest Life Cycles: Adults and nymphs are both green in color. Legs are spinier than WLH. There is a series of six white spots on the pronotum (the shield immediately behind the head). This species is more active on the leaf than WLH. Nymphs will run sideways, quickly running to the other side of the leaf as the leaf is examined. PLH overwinters in the Gulf Coast states, and must reinvade the northeast region each spring. Adults arrive in mid-May to late June. Adults are the first stage seen. Nymphs resemble small adults without wings. This species, unlike WLH, has a toxic saliva which causes xylem and phloem tubes to collapse, causing the inability of water and nutrients to reach the leaf and of photosynthates to leave the leaf. There are several (usually 2-4) overlapping generations. Nymphs emerge until mid-September and adults are present until mid-October, although densities are usually very low by this time because of the lack of young leaves.
Timing of Control: Treatments are when adults first appear in young blocks, especially if PLH has been a problem in the area in the past.
Yield Losses: <1%
Regional Differences: Statewide
Cultural Control Practices: Worse in younger trees
Biological Control Practices: NA
Post-Harvest Control Practices: NA
Other Issues: Damage may be severe to non-bearing trees; damage may have effects on early establishment.

Chemical Controls for Potato Leafhopper*:

carbaryl (Sevin 50WP)	5	Cover	1 lb/100 gal	Summer, as insects appear	1	1	12
carbaryl (Sevin 4EC)	0	Cover	0.5 qt/100 gal	Summer, as insects appear	1	1	12
carbaryl (Sevin 80S)	5	Cover	2/3 lb/100 gal	Summer, as insects appear	1	1	12
dimethoate (Dimethoate 4EC)	5	Cover	1 pt/100 gal	Summer, as insects appear	1	28	48
endosulfan (Thiodan 50WP)	10	Cover	1 lb/100 gal	Summer, as insects appear	1	21	24
endosulfan (Thiodan 3EC)	0	Cover	2/3 qt/100 gal	Summer, as insects appear	1	21	24
formetanate hydrochloride (Carzol 92SP)	5	Cover	2-4 oz/100 gal	Summer, as insects appear	1	7	48
imidacloprid (Provado 1.6F)	50	Cover	1-2 oz/100 gal	Summer, as insects appear	1	7	12
methomyl (Lannate 2.4L)	10	Cover	0.75 pt/100 gal	Summer, as insects appear	1	14	72
oxamyl (Vydate 2L)	10	Cover	1-2 pt/100 gal	Summer, as insects appear	1	14	48

*Sprays used for OBLR using Lorsban or Asana will provide some control of PLH

17. Redbanded Leafroller

Type of Pest: Insect
Frequency of Occurrence: rare
Damage Caused: RBLR damages both foliage and fruit, but foliar damage is not significant except in cases of very severe infestations. Leaf-feeding by young larvae produces a skeletonized band near the midrib or veins. The young larval stages of all broods tend to feed on the leaves, but they prefer fruit as they become larger. Damage to the fruit causes concern and economic loss to the grower. Fruit damage by the first brood larvae is likely to occur when two fruit are tied together with webbing, and can be quite deep, because the fruit are small. These damaged areas eventually cork over, resulting in deformed fruit. Damage to the larger fruit by the summer broods is typically shallow and irregular; in contrast, other leafrollers have deeper feeding patterns. These later broods of RBLR tend to tie a leaf to the fruit and feed on it under its protection. Damage by the summer broods can be late enough in the season that corking may not occur, leaving exposed tissue. Such exposed tissue is susceptible to rot diseases and moisture loss, and the injured fruit do not store well.
% Acres Affected: <5%
Pest Life Cycles: The adult RBLR is reddish-brown with lighter markings of silver, grey, and orange. The name of the pest refers to the distinct reddish-brown band extending across the wings, and its habit of rolling, folding, or attaching leaves together. The RBLR measures 6.3 to 9.5 mm (3/8 to 1/4 in.) long. The male is smaller than the female, and has a slender, tubular abdomen with a tuft of hairs at the tip. The female's abdomen is wider than the male's, spindle-shaped, and bluntly rounded at the end. The first RBLR moths emerge in the spring from overwintered pupae in the ground cover, before or soon after the green-tip stage of apple (early April). This first flight peaks in the tight cluster to pink bud stages. The moths can be found resting on trunks and scaffold limbs, and can sometimes be flushed from the ground cover. The second adult flight occurs from mid-June to mid-July, and the third flight, if it occurs, is from late August to mid September.

Eggs are laid in groups of a few to nearly 150, but a typical egg mass usually contains about 40 eggs deposited in oval patches that measure 3.0 by 5.0 mm (1/16 by 3/16 in.). The eggs resemble overlapping scales in the patch, and are pale yellow or cream colored. Each egg is about 0.8 mm (1/32 in.) in diameter. First brood eggs appear in the pink to early-bloom periods, and are laid primarily on the trunk and scaffold limb bark; hatch coincides with the petal fall stage of apples (mid-May). The summer brood eggs, which are more difficult to find, are laid mostly on the upper surfaces of leaves.

The larva is small, unmarked, and green to pale yellow, depending on the food consumed. The head capsule and thoracic shield (the hardened plate behind the head) are the same color (green to yellow) as the rest of the body. This is important in distinguishing RBLR from other leafrollers, in which the head and thoracic shield are darker than the rest of the body. Newly-emerged larvae are about 1.6 mm (1/16 in.) long; the last larval stage is about 16 mm (5/8 in.) long. First brood larvae crawl along trunks and limbs in search of leaves to eat; watersprouts are readily accepted as food. Small larvae feed on leaf undersides near the midrib or large veins, and spin a flimsy web, which expands as the larva grows. Larvae are more likely to feed on fruit as they grow. As with the first brood larvae, those of the second brood feed on the undersides of leaves within a web. In late August and early September they begin to move about on the tree and feed more on fruit, and this feeding may continue until October, when they fold a leaf around themselves and pupate within.

Pupae are initially greenish-brown, but later turn a deep brown. They are 9.5 to 12.8 mm (3/8 to 1/2 in.) long. RBLR overwinters as a pupa in a folded leaf in the ground cover, whereas summer brood pupae can be found on the tree in folded leaves or in two leaves fastened together.

Timing of Control: Chemical sprays directed at RBLR larvae in orchards are typically applied at petal fall and in cover sprays according to action thresholds. Thorough coverage is essential for good control. In extreme cases, sprays are sometimes applied against overwintering brood adults at half-inch green stage. During the last several years, pink and petal fall sprays have adequately controlled this pest.

Yield Losses: <5%

Regional Differences: perhaps more severe in Hudson Valley

Cultural Control Practices: NA

Biological Control Practices: Egg parasites are very effective biological control agents in unsprayed trees, but are apparently eliminated by the sprays applied in commercial orchards.

Post-Harvest Control Practices: NA

Other Issues: RBLR may be suppressed by covers for other pests.

Chemical Controls for Redbanded Leafroller:

azinphos-methyl (Guthion 50WP)	60	Cover	0.5 lb/100 gal	Late July and Early August for 2nd brood control	2	7	48
phosmet (Imidan 70WP)	30	Cover	0.75-1 lb/100 gal	Late July and Early August for 2nd brood control	2	14	24
B.t. (Javelin 7.5WDG)	0	Cover	1/8-1 lb/100 gal	Late July and Early August for 2nd brood control	2	0	4
B.t. (Dipel 2X 6.4WP)	2	Cover	2-8 oz/100 gal	Late July and Early August for 2nd brood control	2	0	4
B.t. (Dipel 10.3DF)	1	Cover	2-8 oz/100 gal	Late July and Early August for 2nd brood control	2	0	4
B.t. (Biobit 1.6FC)	1	Cover	8-28 oz/100 gal	Late July and Early August for 2nd brood control	2	0	4
B.t. (MVP 0.9FM)	1	Cover	0.25-1 qt/100 gal	Late July and Early August for 2nd brood control	2	0	4
B.t. (Agree WG 3.8WS)	1	Cover	0.25-0.5 lb/100 gal	Late July and Early August for 2nd brood control	2	0	4
methomyl (Lannate 2.4L)	4	Cover	0.75 pt/100 gal	Late July and Early August for 2nd brood control	2	14	72

18. Rosy Apple Aphid

Type of Pest: Insect

Frequency of Occurrence: The RAA will attack all apple varieties, but varieties such as Cortland, Monroe, Rhode Island Greening, Ida Red, and Golden Delicious are particularly susceptible.

Damage Caused: RAA feeding causes apple leaves to curl and often turn a bright crimson. Leaf curling normally does not become obvious until about petal fall. Feeding on the leaves of fruit clusters often results in bunching, stunting, and malformation of the fruit, which becomes noticeable as the fruit develops and renders it unmarketable. Honeydew produced by the aphids provides a media for the growth of a sooty mold fungus which can affect the fruit finish.

% Acres Affected: potential 50%; actual 10%

Pest Life Cycles: The RAA produces eggs only in the fall and continues to do so until heavy frosts kill all the females. The aphid overwinters in the egg stage. The ovate eggs, which measure 0.4 mm in length, are laid in the fall on twigs, bud axils, or in crevices in the bark. The eggs are a pale green color when first laid and then turn shiny black, and are impossible to differentiate from apple grain aphid and green apple aphid eggs. The eggs hatch between silver tip and half-inch green.

The RAA passes through 5 nymphal instars, increasing in size from 0.4 to 2.0 mm. As the aphids grow, their color changes from dark green to rosy brown or purple and they acquire a powdery white covering. In early spring, the RAA move to the developing fruit clusters and become reproductive adults during bloom. It takes 2 to 3 weeks for a RAA to mature.

The overwintering eggs give rise to only female aphids known as stem mothers which give birth to living young. A few winged adults are produced in the second generation and proportionately more are produced in the third and fourth generations. These winged adults, produced between May and mid-July, leave the apple trees and move to weed host plants to spend the summer. The winged migrant adults are colored brownish-green and black and are 2.0-2.5 mm in length. Narrow-leaved plantain and dock are two of the more important summer hosts for the RAA. They feed and produce wingless asexual forms until late summer or early fall when winged adults are again produced and the RAA migrates back to the apple trees. These adults produce offspring that in turn produce both male and female offspring. This is the only time male RAA are produced. When these males and females become adults, they mate and the females lay eggs to carry the species through the winter.

Timing of Control: tight cluster to pink; post-petal fall

Yield Losses: <10%

Regional Differences: Statewide

Cultural Control Practices: NA

Biological Control Practices: Although there are several predators or parasites of the RAA, they cannot be relied upon to provide acceptable biological control.

Post-Harvest Control Practices: NA

Other Issues: Postbloom application generally will not prevent fruit damage.

Chemical Controls for Rosy Apple Aphid:

chlorpyrifos (Lorsban 4EC)	50	Pre-bloom	1 pt/100 gal	Tight cluster to pink	1	1/2 inch green	24
methidathion (Supracide 2EC)	5	Pre-bloom	1-2 pt/100 gal	Tight cluster to pink	1	1/2 inch green	48
chlorpyrifos (Lorsban 50WS)	0	Pre-bloom	12 oz/100 gal	Tight cluster to pink		28	24
diazinon (Diazinon AG 600)	5	Pre-bloom	12.75 oz/100 gal	Tight cluster to pink	1	21	24
dimethoate (Dimethoate 4EC)	0	Pre-bloom	1 pt/100 gal	Tight cluster to pink		28	48
endosulfan (Thiodan 50WP)	10	Pre-bloom	1 lb/100 gal	Tight cluster to pink		21	24
endosulfan (Thiodan 3EC)	10	Pre-bloom	2/3 qt/100 gal	Tight cluster to pink		21	24
methomyl (Lannate 2.4L)	2	Pre-bloom	0.75 pt/100 gal	Tight cluster to pink		14	72
oxamyl (Vydate 2L)	2	Pre-bloom	1-2 pt/100 gal	Tight cluster to pink		14	48
imidacloprid (Provado 1.6F)	25	Post-bloom	2 oz/100 gal	Petal fall to first cover		7	12
esfenvalerate (Asana XL 0.66EC)	30	Cover	2.5-8 oz/100 gal	Prebloom	1	21	12

19. San Jose Scale

Type of Pest: Insect

Frequency of Occurrence: Annually in old, poorly pruned blocks

Damage Caused: SJS infestations on the bark contribute to an overall decline in tree vigor, growth, and productivity. Feeding on the fruit induces local red to purple discoloration around the sites of feeding and decreases the cosmetic quality of the crop. Early season fruit infestations may result in small deformed fruit. Since crawlers are produced continuously over the season, fruit infestations are a constant threat once crawlers begin to emerge.

% Acres Affected: <10%

Pest Life Cycles: Adult male SJS are minute, winged insects, about 1 mm long and golden brown in color. Following a period of maturation beneath elongate scale covers, males emerge in flights to search out female SJS and mate. Male SJS flights coincide with the females' period of receptivity and their production of a sex pheromone. The seasonal male flight pattern is characterized by a distinct spring flight which often occurs during apple bloom. This is followed by a series of up to 3 overlapping flights from mid-summer through autumn. The scale covering secreted by adult female SJS is circular and composed of concentric rings of gray-brown wax radiating from a tiny white knob and measures about 1.4 mm across. The actual insect body, found beneath the scale, is bright yellow, lacks appendages, and is almost circular in outline. Female SJS do not deposit eggs, but rather produce live crawlers within 4 to 6 weeks following mating. A female may produce crawlers for 6 to 8 weeks at a rate of about 10 per day.

Crawlers are bright yellow, mobile forms which resemble larval spider mites and measure about 0.24 mm by 0.1 mm. After exiting from beneath the female's cover, the crawlers walk or are air-borne to new sites of infestation on the bark, fruit, and leaves. Within 24 hours following birth, crawlers settle, tuck in their legs and antennae, and insert their mouthparts into the host. After settling, the first instar nymph secretes a white waxy covering and is known as the "white-cap" form. The third and final phase of the first instar (the "black-cap") is initiated as peripheral rings of darkened wax are secreted and the "white-cap," except for its center tuft, blackens. The first molt occurs beneath the "black-cap" within 3 weeks following crawler emergence. The scale covering of the immobile second instar females gradually increases in diameter to accommodate the growing insect beneath. A second and final molt to the adult stage female occurs 3 to 4 weeks later. Males become distinguishable from females during the second instar as their scale coverings elongate. Following the second molt, male SJS pass through two non-feeding instars prior to the final molt to adults. The SJS overwinters on bark in the "black-cap" phase of the first instar. Development resumes as spring temperatures exceed 10°C (50° F). In warmer climates, gravid females may also survive the winter. First generation crawler production by all overwintering stages is synchronized, and usually occurs within 4 to 6 weeks following bloom.

Timing of Control: Control measures for SJS are recommended when the scale or their feeding blemishes have been found on fruit at harvest during the previous season.
Yield Losses: <5%
Regional Differences:
Cultural Control Practices: Examination of the bark and twigs during pruning may be valuable in detecting infestations which are not otherwise apparent since populations are often irregularly distributed within orchards and may be hidden beneath loose bark in older trees. Pruning is also important in removing infested branches and suckers, as well as opening up the canopy to allow for better spray coverage in tree tops where SJS are often concentrated.
Biological Control Practices: Several chalcid wasps are known to parasitize the SJS, but none has demonstrated effective control in commercial orchards.
Post-Harvest Control Practices: NA
Other Issues: Because good postbloom miticides are available, growers are using less dormant oil, thus increasing the incidence of scale problems.

Chemical Controls for San Jose Scale:

oil	60	Prebloom	2 gal/100 gal	Dormant to Half-inch green	1-2	0	12
chlorpyrifos (Lorsban 4EC)	20	Prebloom	1 pt/100 gal	Half-inch green	1	1/2 inch green	24
methidathion (Supracide 2EC)	2	Prebloom	1-2 pt/100 gal	Half-inch green	1	1/2 inch green	48
methidathion (Supracide 25WP)	2	Prebloom	0.5 lb/100 gal	Half-inch green	1	1/2 inch green	48
azinphos-methyl (Guthion 50WP)	2	Cover	1/2-5/8 lbs/100 gal	June	2	14	48
chlorpyrifos (Lorsban 50WS)	10	Cover	8-12 oz/100 gal	June	2	28	24
imidacloprid (Provado 1.6F)	2	Cover	2 oz/100 gal	June	2	7	12
phosmet (Imidan 70WP)	2	Cover	0.75-1 lb/100 gal	June	2	7	24

20. Sparganothis Fruitworm

Type of Pest: Insect
Frequency of Occurrence: Sporadic in problem orchards
Damage Caused: Pinholes on fruit surface caused by larval feeding.
% Acres Affected: <10%
Pest Life Cycles: Overwinter as 3rd instar; adults fly after petal fall, 2nd generation in late July.
Timing of Control: June-July
Yield Losses: <10%

Regional Differences: Columbia county and north to Albany.
Cultural Control Practices:
Biological Control Practices: Ineffective
Post-Harvest Control Practices:
Other Issues: Resistant to common organophosphates. No sprays specifically for this pest.

Chemical Controls for Sparganothis Fruitworm:

B.t. *(Biobit 1.6FC)*	1	Cover	8-28 oz/100 gal	June and July	1-2	0	4
B.t. *(Dipel 2X 6.4WP)*	80	Cover	2-8 oz/100 gal	June and July	1-2	0	4
B.t. *(Dipel 10.3DF)*	2	Cover	2-8 oz/100 gal	June and July	1-2	0	4
B.t. *(Javelin 6.4WDG)*	1	Cover	0.25-0.5 qt/100 gal	June and July	1-2	0	4
B.t. *(MVP 0.9FM)*	1	Cover	0.25-1 qt/100 gal	June and July	1-2	0	4
methomyl *(Lannate 2.4L)*	15	Cover	0.75-1.5 pts/100 gal	June and July	1-2	14	72

21. Spotted Tentiform Leafminer

Type of Pest: Insect
Frequency of Occurrence: Annually in most orchards.
Damage Caused: STLM injury, due to feeding within the mines, reduces the photosynthetic capability of the leaves and disrupts the growth regulating and ripening processes governed by hormones produced in the leaves. Severe STLM infestations may cause leaf drop, premature ripening and fruit drop. Injury from mining may also sensitize the leaf tissues, making them more susceptible to spray injury.
% Acres Affected: potential 100%; actual 10-40%, greater than 75% in Hudson Valley
Pest Life Cycles: STLM adults are slender, brown moths with distinct silver to cream colored markings on the upper wings. Their length (2.3-3.8 mm) varies between species and generations. The moths that emerge in the early spring from overwintering pupae tend to be larger and darker than adults of the other two generations. Adults begin emerging from overwintering pupae at the half-inch green or tight cluster stage of McIntosh bud development. Mating and egg laying occur in the evening. A female will lay an average of 25 eggs.

STLM eggs are small (0.3 mm in diameter), elliptical, and creamy to transparent in color. The eggs are laid on the undersides of leaves and, depending on temperature, hatch in 5-16 days.

STLM larvae have five instars. The first three instars are referred to as the "sap feeding stage" because they feed on the sap from the spongy mesophyll of the leaves. In the process of feeding, they separate the outer layer of the leaf undersurface from the tissue above and the mines are only visible from the under leaf surface. The fourth and fifth instars feed more on the leaf tissues and are referred to as the "tissue feeding stage." Their feeding gives the mines a tent-like appearance with visible spots where the green tissue has been removed. When full grown, the larvae are about 4 mm long, cylindrical, and white to pale green in color. Prior to pupation, the larvae turn yellow. Larval development takes about 24 days to complete for the first and second generations and considerably longer for the third.

STLM pupae are 3-4 mm long and change in color from yellow, when first formed, to dark brown. The pupal period lasts about 1.5 weeks for the first two generations and extends through the winter for the third generation. Prior to emergence as an adult, the pupa cuts through and partially protrudes from the lower leaf surface of the mine. The pupal skin remains attached to the leaf after the adult has emerged.
Timing of Control: Chemical control of the STLM is recommended for the first and second generations. Injury from the third generation develops on most apple varieties too late in the season to be a serious problem. Also, omission of pesticide use against the third generation encourages the establishment of natural enemies.
Yield Losses: Indirect pest; stresses tree's productivity. When severe, can cause >50% fruit drop; long term effects on tree can be significant.
Regional Differences: Statewide
Cultural Control Practices:
Biological Control Practices: Several parasites and predators attack the STLM. Spray programs against the STLM and other pests, however, reduce or eliminate the control of the beneficial species in commercial orchards.
Post-Harvest Control Practices:
Other Issues: Allowing 3rd generation to go untreated can allow for maximum effect of natural enemies.

Chemical Controls for Spotted Tentiform Leafminer:

esfenvalerate (Asana XL 0.66EC)	20	Prebloom and Cover	2-5.8 oz/100 gal	1st pink 2nd early July 3rd mid-August	1 each	21	12
oxamyl (Vydate 2L)	10*	Prebloom and Cover	1 pt/100 gal	1st pink 2nd early July 3rd mid-August	1 each	14	48
permethrin (Ambush 2EC)	2	Prebloom and Cover	1.6-6.4 oz/100 gal	1st pink to petal fall	1	PF	12
permethrin (Ambush 25WP)	1	Prebloom and Cover	1.6-6.4 oz/100 gal	1st pink to petal fall	1	PF	12
permethrin (Pounce 3.2EC)	2	Prebloom and Cover	1-2 oz/100 gal	1st pink to petal fall	1	PF	12
imidacloprid (Provado 1.6F)	60**	Cover	2 oz/100 gal	1st pink 2nd early July 3rd mid-August	1 each	7	12
methomyl (Lannate 2.4L)	5	Prebloom and Cover	0.75 pt/100 gal	1st pink 2nd early July 3rd mid-August	1 each	14	72

PF=Petal Fall
*55% in Eastern NY
** 10% in Eastern NY

22. Tarnished Plant Bug

Type of Pest: Insect
Frequency of Occurrence: Sporadic
Damage Caused: The tarnished plant bug causes injury to tree fruits when it feeds and lays eggs. Damage occurs primarily in the spring on flower buds, blossoms, and young fruit, although bleeding of sap may result from twig and shoot injury. The insect feeds first on buds and later on developing fruit. Small droplets of exudate may be present on the surface of injured buds. Within 1 or 2 weeks, the flower clusters may appear dried and the leaves distorted, with a distinct hole where the insect fed. Generally, later damage to developing fruit is more important than earlier feeding on flower buds. In apples, feeding can cause punctures or deep dimples to form as the fruit develops. The damage to apples caused by egg laying is usually deeper, resulting in more distorted fruit often with blemishes or "scabs." Damage early in the season tends to be near the calyx end of the fruit, and later injuries tend to be elsewhere. Cultivars differ in their susceptibility to damage, with depressions or scabs in some being less pronounced. Damage to mature trees is slight after June, but much damage can occur to nursery stock throughout the summer. Nursery apple trees damaged by the tarnished plant bug have curled leaves and stunted growth.
% Acres Affected: 10-20%
Pest Life Cycles: Adults are 6 to 6.5 mm (0.25 in.) long, oval, and somewhat flattened. They are greenish brown in color, with reddish brown markings on the wings. A distinguishing characteristic is a small but distinct yellow-tipped triangle in the center of the back, behind the head. Tarnished plant bugs overwinter as adults under leaf litter, stones, and tree bark and in other protected places. At the end of April, the adults become active and begin laying eggs in crop and weed hosts. The overwintering adult population peaks at about the pink stage of apple (early May in New York). Two to four indistinct generations can occur annually, with development from egg to adult taking 25 to 40 days. Adults feed throughout the summer, but are found on apple trees from the silver tip stage until 2 to 3 weeks after petal fall.

Eggs are about 1 mm (0.04 in.) long, cream colored, and flask shaped. They are laid in plant tissue so only the small anterior end is visible. Eggs can be laid on fruit crops, but are generally deposited on weeds and grasses. On apple trees, although some early oviposition may take place in the buds, most eggs are laid in the developing fruit starting at bloom.

Eggs hatch into nymphs about 7 days after being laid. Young nymphs are pale green and resemble aphids, except that their legs are more robust, their movements are more rapid, and they have no abdominal cornicles (backward-pointing structures that resemble short stems). Because the tarnished plant bug has incomplete metamorphosis, the nymphs resemble adults without wings. Newly hatched nymphs are about 1 mm (0.04 in.) long and remain greenish throughout their five stages, or instars. Nymphs in later instars turn brown and develop wing pads. They have two black dots on their thorax, two between their developing wing pads, and one in the middle of their abdomen.
Timing of Control: No later than pink

Yield Losses: <5%
Regional Differences: More severe in eastern NY
Cultural Control Practices: Some evidence that elimination of legumes will lessen incidence.
Biological Control Practices: The tarnished plant bug has a number of natural enemies, such as other true bugs (nabids, geocorids), ladybird beetles, spiders, and parasitic wasps, but they are not able to control the pest effectively.
Post-Harvest Control Practices: NA
Other Issues: Satisfactory chemical control is difficult on tree fruits because the frequently long bloom period, when no pesticides can be applied, prevents optimum timing of control sprays. Also, prebloom pesticide treatments may dissipate during the prolonged period of bloom. The mobility of the tarnished plant bug also makes control difficult.

Chemical Controls for Tarnished Plant Bug:

esfenvalerate (Asana XL 0.66EC)	70	Prebloom	2-5.8 oz/100 gal	From tight cluster to pink	1	21	12
dimethoate (Dimethoate 4EC)	5	Prebloom	12.8 oz/100 gal	From tight cluster to pink	1	28	48
oxamyl (Vydate 2L)	5	Prebloom	1 pt/100 gal	From tight cluster to pink	1	14	48
permethrin (Ambush 2EC)	5	Prebloom	1.6-6.4 oz/100 gal	From tight cluster to pink	1	PB	12
permethrin (Ambush 25WP)	5	Prebloom	1.6-6.4 oz/100 gal	From tight cluster to pink	1	PB	12
permethrin (Pounce 3.2EC)	5	Prebloom	1-2 oz/100 gal	From tight cluster to pink	1	PB	12
permethrin (Pounce 25WP)	5	Prebloom	1.6-6.4 oz/100 gal	From tight cluster to pink	1	PB	12

PB=Prebloom

23. Variegated Leafroller

Type of Pest: Insect
Frequency of Occurrence: Sporadic
Damage Caused: A shotgun pattern of isolated feeding sites on the fruit is typical
% Acres Affected: <10%
Pest Life Cycles: There is considerable sexual dimorphism in this species. Males are dark brown with a golden or cream colored band on the apical quarter of the wings. Females have several bands of varying shades of brown or reddish-brown on their wings. There is a pale patch near the base of the wings followed by a darker brown median stripe. The outer third of the wings is paler, but with a dark spot near the front edge of the wing. Wingspan of the female is 1/2-3/4 inch (14-19 mm), that of the male is ca. 1/2 inch (12-14 mm). First and second stage larvae are yellowish with a black head capsule, and are about 1/20 inch (1.2 mm) long. Older larvae are green with a light brown or amber head capsule; the sides of the body are lighter green than the top. The thoracic shield is deeper amber, with the color becoming more pale towards the edge. Larvae reach a length of about 3/4 inch (20 mm). Pupae are brown and may be found in folded leaves, either on the ground or hanging by the partially severed petiole. Pupae are about 4/10 inch long (9.3 mm for females, 9.1 mm for males). This bivoltine (two generations) leafroller has a similar life history to TABM. TABM is usually present to some degree in orchards where VLR predominates. However in such orchards, VLR usually has a stronger second flight, usually causing more injury than the first generation. Larvae of various ages overwinter in the ground cover, feeding on weeds (e.g. narrowleaf plantain, smartweed, dandelion, dock and others). VLR adults become active in the spring about 7-10 days later than TABM. Adults emerge from early May to mid-June in the first flight, and from mid-July to late August for the second flight. In some years there may be a partial third generation. Eggs appear as flat green masses, of oval or irregular shape, usually containing 50-70 eggs. A typical egg mass is 1/10 x 3/10 inch (3x8 mm). Females lay an average of 5-6 egg masses. Eggs undergo a progression of color through olive-green, yellow-brown, and later with black head capsules visible in each egg in the mass. Eggs are deposited only on the top surfaces of leaves. Oviposition by the first generation starts about the first week of June, peaking in late June. The egg stage lasts about 13 days in the first generation. Egg hatch starts in mid-May, peaking in mid-June. Larvae require 20-42 days to reach pupation, averaging 35. The young larva cuts partially through the leaf petiole, causing the leaf to become less turgid. The leaf is then tied to another leaf, forming a protected area in which to feed. Occasionally the leaf is tied to a fruit, leading to the feeding injury of economic concern. Second generation oviposition starts in mid-July, peaking in late July and early August. The second generation egg stage lasts about 9 days, with about 50 eggs per mass. The second generation usually causes the most injury and can be important in the weeks approaching harvest.

Timing of Control: 3rd cover through harvest
Yield Losses: <10%
Regional Differences: Mainly in Ulster and Orange counties, near Hudson River.
Cultural Control Practices: Pheromone traps are used. Hang traps about 6.5 feet (ca. 2 m) in height at petal fall. Monitor pheromone traps weekly. At peak flight start searching for egg masses. When masses are found, flag them in order to monitor egg development, and appearance of the black-head stage. Emphasize monitoring and control where VLR has been a problem in previous generations. Peak egg densities occur very soon after peak adult activity.
Biological Control Practices: Larvae are parasitized by a variety of fly and wasp species, and are subject to infection by a virus.
Post-Harvest Control Practices:
Other Issues: Appears to be susceptible to OP's used during AM window

Chemical Controls for Variegated Leafroller:

B.t. *(Biobit 1.6FC)*	1	Cover	8-28 oz/100 gal	June and July	1-2	0	4
B.t. *(Dipel 2X 6.4WP)*	80	Cover	2-8 oz/100 gal	June and July	1-2	0	4
B.t. *(Dipel 10.3DF)*	2*	Cover	2-8 oz/100 gal	June and July	1-3	0	4
B.t. *(Javelin 6.4WDG)*	1	Cover	0.25-0.5 qt/100 gal	June and July	1-2	0	4
B.t. *(MVP 0.9FM)*	1	Cover	0.25-1 qt/100 gal	June and July	1-2	0	4
methomyl *(Lannate 2.4L)*	15	Cover	0.75-1.5 pt/100 gal	June and July	1-2	14	72

*95% in Eastern NY; August 1 – harvest (specific applications rarely made in AM areas)

24. White Apple Leafhopper

Type of Pest: Insect
Frequency of Occurrence: Annually
Damage Caused: WALH nymphs and adults are mesophyl feeders. Feeding injury causes a white mottling of the leaves and with heavy infestations the leaves can become nearly completely white. Feeding WALH also excrete a honeydew which may drop onto lower leaves and fruit. Once dried on the fruit, the honeydew appears as "tobacco juice" colored spots or streaks that are difficult to remove. Under humid conditions, the honeydew remains moist and is an excellent media for sooty molds.
% Acres Affected: potential 100%; actual 20%. 90% in Hudson Valley.
Pest Life Cycles: The first WALH adults begin appearing in early June. They are a pale yellowish-white color and measure about 3 mm long. Under close observation, particularly on the males, a slight orange tinge may be seen on the head and thorax. Female WALH have about a 10-day preoviposition period and then produce eggs for about 3 weeks. They may live about a week after oviposition ceases. Second brood WALH adults begin emerging about mid-August and by early September most have emerged. They normally remain active until killed by the first good frost in the fall. When present in large numbers at harvest, second brood WALH adults can be a nuisance problem to pickers.

The overwintering WALH eggs are deposited by the second brood females just beneath the bark surface on 1- to 5- year old wood. These egg laying sites appear as elongate, oval, blister-like swellings, measuring about 1.5 mm long, and characteristically run perpendicular to the terminal growth. Overwintered eggs begin hatching about late pink and hatch is completed by petal fall. The second brood eggs are laid in the petiole, mid-vein and large veins of leaves from late June through mid July. These eggs begin hatching in late July and in some years emergence may continue into September.

Newly hatched WALH nymphs are about 1 mm long, pale white and wingless. The eyes of newly hatched nymphs are red and change to a pale white color with the first molt. They migrate to the undersurface of older leaves where they begin feeding. WALH nymphs pass through 5 instars and will characteristically complete their development on a single leaf or cluster of leaves. Their white cast skins frequently remain hanging from the leaf undersurface. As the nymphs reach the third instar the wing pads become noticeable. Fifth instar WALH nymphs measure about 2.8 mm long.
Timing of Control: Petal fall and summer. One application for each generation.
Yield Losses: <10%. Effects on fruit size difficult to measure. Fecal spotting of fruit could decrease packout by 50-100%.
Regional Differences: Perhaps most serious in lower Hudson Valley, where WALH second generation is concurrent with rose leafhopper.

Cultural Control Practices: Damage may be lessened by elimination of multiflora rose, the overwintering host of rose leafhopper.
Biological Control Practices: Several parasites, predators, and a fungus attack the WALH. Normally, natural enemies cannot adequately control the WALH in commercial orchards and growers must rely on insecticidal control.
Post-Harvest Control Practices: None
Other Issues: The WALH has developed resistance to the organophosphate insecticides in many apple growing regions.

Chemical Controls for White Apple Leafhopper:

carbaryl (Sevin 50WP)	40	Cover	1 lb/100 gal	Petal fall and mid-late summer	1-2	1	12
carbaryl (Sevin 4EC)	0	Cover	0.5 qt/100 gal	Petal fall and mid-late summer	1-2	1	12
carbaryl (Sevin 80S)	40	Cover	2/3 lb/100 gal	Petal fall and mid-late summer	1-2	1	12
dimethoate (Dimethoate 4EC)	2	Cover	1 pt/100 gal	Petal fall and mid-late summer	1-2	28	48
endosulfan (Thiodan 50WP)	10	Cover	1 lb/100 gal	Petal fall and mid-late summer	1-2	21	24
endosulfan (Thiodan 3EC)	0	Cover	2/3 qt/100 gal	Petal fall and mid-late summer	1-2	21	24
formetanate hydrochloride (Carzol 92SP)	1	Cover	2-4 oz/100 gal	Petal fall and mid-late summer	1-2	7	48
imidacloprid (Provado 1.6F)	1	Cover	2 oz/100 gal	Petal fall and mid-late summer	1-2	7	12
methomyl (Lannate 2.4L)	5	Cover	0.75 pt/100 gal	Petal fall and mid-late summer	1-2	14	72
oxamyl (Vydate 2L)	1	Cover	1-2 pt/100 gal	Petal fall and mid-late summer	1-2	14	48

25. Woolly Apple Aphid

Type of Pest: Insect
Frequency of Occurrence: Annually in problem orchards
Damage Caused: Cottony-white aerial colonies are found most frequently on succulent tissue, such as current season's growth, water sprouts, unhealed pruning wounds, or cankers. Heavy infestations can cause honey dew and sooty mold on the fruit, and galls on the plant parts. Underground colonies may be found throughout the year on the root systems of orchard trees or nursery stock. Severe root infestations can stunt or kill young trees, but usually cause little damage to mature trees. WAA can also transmit perennial apple canker.
% Acres Affected: 30%; some varieties more susceptible.
Pest Life Cycles: Adult woolly apple aphids are wingless until a generation is produced that can migrate to a different host. Wingless adult females bearing live young are found on apple trees during the summer. This adult form is dark brown to purplish, and 1.8 mm (.07 in.) long. In aerial colonies, it has a long, white, filamentous waxy secretion. In underground colonies it has a more bluish-white, rod-like secretion. Several wingless generations of WAA are produced on apple trees throughout the season. Some winged females are produced that could migrate to other apple trees or to elm, if it is present. On elm, winged females produce wingless males and females that mate and lay eggs. Male woolly apple aphids are found only at this time.

Eggs are uncommon in the life cycle of the WAA, being produced only when an apple and an elm tree are in close proximity. Rarely, sexual forms of the WAA and eggs are produced on apple trees. The eggs are elliptical, 0.6 by 0.3 mm (approximately .02 in. long), brown to purplish in color, and embedded in a waxy secretion. The eggs overwinter in crevices of the elm bark. After three generations on elm, a winged form is produced that migrates to apple trees.

The majority of nymphs are borne alive on apple trees by an unmated female. The WAA nymph passes through four instars, changing in size from 0.6 mm (.02 in.) long in the first to 1.3 mm (.05 in.) long in the fourth instar. The nymphs are dark reddish-brown with a bluish-white waxy covering that becomes more extensive in the later instars. The first instar nymphs (crawlers), which are considerably more active than later instars, are a dispersal stage. They initiate aerial colonies in the spring from overwintering root infestations. The crawlers are carried by wind from tree to tree within an orchard or nursery, or move downward from the branches to initiate colonies on roots.
Timing of Control: July, when colonies begin to appear in canopy.

Yield Losses: <15% for fruit feeders; effect of root-feeding stage unknown.
Regional Differences: Statewide
Cultural Control Practices: Chemical control of root infestations is not possible; resistant rootstocks provide the only defense against underground infestations. The Malling-Merton (MM) rootstock series was developed to provide resistance to WAA infestation.
Biological Control Practices: The WAA is frequently parasitized by Aphelinus mali, a tiny wasp that is also native to North America. Parasitized aphids appear as black mummies in the colony. A. mali has been successfully introduced to many apple-growing areas of the world, and is providing adequate control of the WAA in several areas. It does not provide sufficient control in commercial orchards in the northeastern United States because of its sensitivity to many commonly used insecticides; however, the wasp is thought to reduce WAA populations in abandoned orchards.
Post-Harvest Control Practices:
Other Issues: Because the woolly apple aphids are somewhat protected by their waxy covering, regular spray programs may not provide adequate control. High volume applications of recommended insecticides may be necessary to penetrate the wax. Failure to control aerial infestations can result in underground infestations on susceptible rootstocks.

Chemical Controls for Woolly Apple Aphid:

chlorpyrifos (Lorsban 50WS)	80	Cover	8-12 oz/100 gal	July	1	28	24
endosulfan (Thiodan 50WP)	20	Cover	1 lb/100 gal	July	1	21	24
endosulfan (Thiodan 3EC)	0	Cover	2/3 qt/100 gal	July	1	21	24

26. Apple Rust Mite

Type of Pest: Mite
Frequency of Occurrence: Hot, dry weather favors a rapid buildup of this pest.
Damage Caused: ARM can cause a silvering of foliage, although population densities seldom reach damaging levels. If populations are very high, however, terminal growth will be affected and leaves will curl lengthwise and turn brown. ARM may feed on young fruit in May and June, damaging the epidermis and causing russeting.

The mite overwinters as an adult female under leaf scars or bud scales or in small cracks on twigs. With the advent of warm weather, even before the buds break, these mites are feeding and laying eggs under the bud scales. As the blossom cluster expands to throw off the outer scales, the exposed mites start to migrate toward the developing bloom, resulting in a concentration of active stages in the calyx end of the nearly developed fruit. The young mites from the hatched eggs also feed on the flower stems just prior to bloom. By petal fall, they are feeding vigorously on leaves and at the calyx end of the developing fruit. Later they spread over the tree, also feeding on leaves. Damaged areas of fruit gradually russet or turn brown. In June, the first russetting shows mainly at the calyx end of the fruit, and most russetted fruit is usually on the sunny south or east side of the tree. Once the mites spread out over the tree in large numbers, succeeding generations (several during the season) move onto the fruit from the stem ends and, if not controlled, will gradually russet whole fruits. In July, some females begin to hibernate for the winter, but if the weather is hot and dry for long periods, the mites will go on feeding into August until cool weather occurs, at which time they will seek shelter and overwinter under leaf scars or bud scales.
% Acres Affected: <10%; ~75% in Hudson Valley
Pest Life Cycles: ARM are elongate triangular mites, pale yellow or off-white in color. They are barely discernible using a hand lens (7/1000 inch; 160-175 microns long, ca. 0.2 mm). ARM possess only two pairs of legs (mites generally have four pairs). Winter-form females overwinter in dormant buds and under loose bark on 1-year-old shoots. Mites move into fruit buds between tight cluster and pink, and into vegetative buds as they swell. Mites feed on flower receptacles and fruitlets in May and June. Females deposit eggs on the undersides of leaves, giving rise to males and summer form females. There are several generations before winter-form females appear in July, possibly in response to the hardening of buds. These females return to overwintering quarters at this time. Presence of apple rust mites can condition foliage so that it is less suitable for development of ERM.
Timing of Control: Prebloom and petal-fall sprays are essential to control this pest. Trees must be sprayed dilute from both sides and should be monitored for apple rust mite until harvest.
Yield Losses: Indirect pest. Effects on apple size and tree health unknown; may contribute to premature drop yield losses up to 25%.
Regional Differences: May be more severe in Hudson Valley
Cultural Control Practices:
Biological Control Practices: High population densities can cause injury, but more usual populations are beneficial because ARM is an alternative food source for the predatory mite, Amblyseius fallacis, and the black hunter thrips,

Leptothrips mali.
Post-Harvest Control Practices:
Other Issues:

Chemical Controls for Apple Rust Mite:

dicofol (Kelthane 35WP)	45	Cover	1-2 lb/100 gal	Late June	1	7	12
dicofol (Kelthane 50WP)	45	Cover	0.75-1.5 lb/100 gal	Late June	1	7	12
pyridaben (Pyramite 60WS)	10	Cover	2.2 oz/100 gal	Late season when bronzing appears	1-2	25	12
abamectin (AgriMek 0.15EC)	80	Cover	2.5-5 oz/100 gal	Petal fall to petal fall + 14 days	1	28	12

27. European Red Mite

Type of Pest: Mite
Frequency of Occurrence: Established in most deciduous fruit growing areas. Considered the most important mite species attacking tree fruits in North America.
Damage Caused: Although a pest of all tree fruits, apple and plum suffer most severely. Injury is caused by the feeding of all stages on the foliage. The lower leaf surface is preferred. Under high populations both surfaces are fed upon. The injury is caused by the piercing of the cell walls by the bristle-like mouth parts and the ingestion of their contents, including the chlorophyll. The injury results in off-color foliage which in severe cases becomes bronzed as compared to uninfested foliage. The leaf efficiency and productivity is directly affected. Heavy mite feeding early in the season (late June and early July) not only can reduce tree growth and yield but also drastically affect fruit bud formation, and thereby reduce yields the following year. Additionally, mite-injured leaves will not respond to growth regulators applied to delay harvest drop.
% Acres Affected: potential 100%; actual 35%
Pest Life Cycles: There are 4-9 generations of the ERM a year, depending on the locality and the length of the growing season. The sexes of the adults are readily differentiated. The female has a globular body which ranges in length from 0.38-0.40 mm, is velvety brown to brick red, and has 4 rows of dorsal setae or spines borne on raised white tubercles. The body color and setal pattern distinguish this species from all other plant feeding mites. The male is smaller, 0.26-0.28 mm in length, lighter in color and has a pointed abdomen and proportionately longer legs. The rate of development is temperature dependent, being slower in the spring and fall, and more rapid during the hot summer months. The first generation generally requires about 3 weeks to develop, while summer generations may develop in 10 to 14 days. Reproduction can be both sexual and parthenogenetic. Unfertilized eggs give rise to males only, while mated females produce both sexes. The average preoviposition period of females is about 2 1/2 days. Although some females in insectary studies have lived 39 days, the average life span is 18 days. The oviposition period averages 12.5 days with 18.8 eggs produced per female.

The ERM overwinters as fertilized eggs. The environmental factors triggering winter egg production are diminishing food supply, temperature and photoperiod. The bulk of winter egg deposition occurs from mid to late August, but may continue until late September. Overwintering eggs are deposited in groups, on roughened bark areas, especially around the base of buds and fruit spurs. These eggs may be so numerous that the infested areas take on a reddish cast. Egg hatch is closely correlated with bud development and first occurs when buds are in the tight cluster stage; hatch is better than 50% complete at the pink stage, and virtually 100% complete by the end of bloom. The first summer eggs as a rule can be found at petal fall or at latest by fruit set. The summer eggs are globular and somewhat flattened (onion shaped). They are bright red to dark orange, and average 0.13 mm in diameter. The overwintering egg is deeper red and slightly larger, averaging 0.14 mm. The egg surface is ridged with the grooves running toward the top center from which a slender tapering stalk (0.1 mm) arises. The average incubation period of the summer eggs for each generation varies from 6.7 to 14.4 days, the shortest period being in mid-summer.

The ERM passes through 3 stages between egg hatch and adulthood. They are called the larva, protonymph and deutonymph. A quiescent or resting period precedes each molt to the following stage. The hatching larva is about 0.2 mm in length, light orange in color and 6-legged. All subsequent stages have 8 legs. With the exceptions of an increase in size and the ability to differentiate sexes in the deutonymphal stage, there are no conspicuous changes in structure or color between the nymphal instars. The average developmental time from eclosion to adulthood ranges from 5.5-15 days, depending on the generation.
Timing of Control: The most effective treatments are those applied after new growth has appeared but ahead of bloom.
Yield Losses: Indirect pest; stresses tree's productivity. Potential up to 80%.
Regional Differences: Statewide

Cultural Control Practices:
Biological Control Practices: Mite predators are generally distributed in commercial plantings and contribute to the control of the ERM.
Post-Harvest Control Practices:
Other Issues:

Chemical Controls for European Red Mite:

petroleum oil	50	Delayed Dormant	1-3 gal/100 gal	Any time until pink	1-2	PB	12
clofentezine (Apollo 4SC)	10	Prebloom and Cover	1-2 oz/100 gal	Tight cluster to 1st-2nd cover	1	45	12
hexythiazox (Savey 50WP)	10	Prebloom	3 oz/A	No later than pink	1	Pink	12
abamectin (Agri-Mek 0.15EC)	10	Post-bloom	2.5-5 oz/100 gal	No later than 2 weeks post petal fall	1	28	12
formetanate hydrochloride (Carzol 92SP)	2	Cover	4-8 oz/100 gal	Summer, as needed	1-2	7	48
dicofol (Kelthane 35WP)	2	Cover	1-2 lb/100 gal	Summer, as needed	1-2	7	12
dicofol (Kelthane 50WP)	2	Cover	0.75-1.5 lb/100 gal	Summer, as needed	1-2	7	12
fenbutatin oxide (Vendex 50WP)	1	Cover	4.8 oz/100 gal	Summer, as needed	1-2	14	48
oil (UltraFine or Stylet Oil)	1	Cover	1-2 gal/100 gal	Every 2 weeks starting at petal fall	3-4	0	12
pyridaben (Pyramite 60WS)*	10	Cover	2.2 oz/100 gal	Summer, as needed	1-2	25	12

PB=Prebloom: PH=Postharvest
* not effective in Hudson Valley

28. Twospotted Spider Mite

Type of Pest: Mite
Frequency of Occurrence: Sporadic problem in orchards. Economically damaging populations generally develop during the latter part of the season.
Damage Caused: TSM are indirect pests that feed by extracting leaf sap. A severe infestation can cause leaf bronzing, reduced photosynthesis, fruit size reduction, preharvest drop, poor fruit coloring, and reduced crop potential for the next year.
% Acres Affected: 10-20%
Pest Life Cycles: The adult female mite's summer color pattern varies, but most are greenish yellow with a prominent dark spot on each side near the middle of the body. These spots may enlarge to cover most of each side of the body as the mite feeds. The body is somewhat egg shaped and broadest toward the head region. The eggs are spherically shaped and shiny; their color varies from light or clear to pale green. Twospotted spider mites overwinter as orange-colored females. In orchards, the overwintering females congregate under debris on the orchard floor or bark scales at the base of trees. During the spring the twospotted spider mite feeds on vegetation, especially vetch and other legumes underneath the trees. As these orchard floor hosts dry out with the arrival of hot weather, twospotted spider mites move into trees. Hot, dry weather is favorable to population increases of this mite. The twospotted spider mite passes through the same developmental stages as does the European red mite.
Timing of Control: Chemicals should be chosen for effectiveness, selective toxicity, and lowest toxicity to natural enemies. Also important is alternation of materials, application of the minimum effective dosage of chemicals, and proper timing of sprays.
Yield Losses: Indirect pest; stresses tree's productivity
Regional Differences:
Cultural Control Practices: Mite management emphasizes orchard floor management, scouting of pest and beneficial populations, and consideration of other stresses on the trees.
Biological Control Practices: Natural enemies of plant-feeding mites are very important in the management of these mite populations. Commonly, two predatory mites, Ambelacious fallacis and Zetzellia mali, and the predaceous lady

beetle feed on plant-feeding mites.
Post-Harvest Control Practices:
Other Issues:

Chemical Controls for Twospotted Spider Mite:

abamectin (Agri-Mek 0.15EC)	0	Cover	2.5-5 oz/100 gal	No later than 2 weeks post petal fall	1	28	12
formetanate hydrochloride (Carzol 92SP)	10	Cover	4-8 oz/100 gal	As needed in summer	1-2	7	48
dicofol (Kelthane 35WP)	10	Cover	1-2 lb/100 gal	As needed in summer	1-2	7	12
dicofol (Kelthane 50WP)	10	Cover	0.75-1.5 lb/100 gal	As needed in summer	1-2	7	12
fenbutatin oxide (Vendex 50WP)	10	Cover	4-8 oz/100 gal	As needed in summer	1-2	14	48
pyridaben (Pyramite 60WS)	60	Cover	2.2-3.3 oz/100 gal	As needed in summer	1-2	25	12

IV. Pest Information: Diseases

1. Cedar Apple Rust (CAR) and Quince Rust

Type of Pest: Fungus
Frequency of Occurrence:
Damage Caused: The rust fungi require two hosts, apple and eastern red cedar (Juniperus virginiana L.), to complete their life cycles. Spores produced on apple do not infect apple, but only cedar and spores produced on cedar infect only apple, quince and hawthorne. Before apple can be infected, adequate moisture must be present in a temperature range of 8-24°C (46-75°F) to allow for formation of basidiospores on cedar galls. Then, the basidiospores will infect apple when susceptible leaf and fruit tissues are wet for certain lengths of time at specific temperatures. Leaves are most susceptible to infection when 4-8 days of age, and fruit are susceptible from tight cluster through bloom. CAR affects both fruit and leaves. Quince rust affects only fruit.
% Acres Affected: 20%
Disease Cycle: The CAR fungus overwinters in spherical galls on cedar trees. Spring rains cause horn-like structures, called telia, to extrude from galls. When these horns absorb water, they become jelly-like and swollen. Between rains they dry to dark brown threads. The telial horns are comprised of thousands of two-celled spores called teliospores. Swelling and drying of telial horns may occur 8-10 times during the season. Each time, the horns push out further and expose more teliospores until the supply is exhausted. During rains, after the telial horns absorb water, the teliospores germinate to produce a germ tube (basidium) from each cell. Four basidiospores are produced on each basidium. At optimum temperatures, basidiospores are produced within 4 hours of the horns absorbing water. Basidiospores are forcibly discharged into the air immediately after being formed. They can be carried long distances. Basidiospores that land on young apple tissue may germinate and infect if a film of water is present for an adequate amount of time. One to two weeks after infection, orange pustules (pycnia) containing pycniospores appear on the upper side of leaves or on fruit. One to two months after the appearance of pyonia, the rust produces other fungal structures, called aecia, on the underside of the leaf or on fruit. The aecia produce aeciospores which are released into the air during dry conditions in late summer. Aeciospores that land on young leaves of cedar may germinate, infect, and cause gall formation. Generally, in the second year after infection, the gall matures and produces teliospores, thereby continuing the disease cycle. Because most galls produce teliospores for only one season, a new crop of galls is required each year if infection of apples is to occur. The disease cycle for quince rust is similar, but on cedar trees develops as wood cankers instead of galls.
Timing of Control: Where susceptible cultivars are grown in proximity to red cedars, a fungicide program should be followed from tight cluster through first cover.
Yield Losses: In the absence of fungicides, CAR can cause 100% crop loss and premature defoliation that results in reduced flowering the following year.
Regional Differences: More severe in eastern NY where cedars are abundant. Rare in major apple growing regions of western NY.
Cultural Control Practices: Control strategies for CAR are based on fungicides, removing nearby red cedars, and using resistant varieties. CAR can be minimized on susceptible cultivars if red cedars are eliminated from their vicinity, but this is usually not possible because cedars are on land not owned by apple growers.
Biological Control Practices:

Post-Harvest Control Practices:
Other Issues:

Chemical Controls for Apple Rust:

fenarimol (Rubigan 1EC)	20	Combination with contact fungicide	3 oz/100 gal	Tight cluster, pink, bloom, petal fall, 1st cover	3-5	30	12
ferbam (Ferbam 76WP)	3		1-1.5 lb/100 gal	Tight cluster, pink, bloom, petal fall, 1st cover	5-6	7	24
mancozeb (Dithane 75DF/80WP)	25		0.75-1 lb/100 gal	Tight cluster, pink, bloom, petal fall, 1st cover	5-6	77	24
mancozeb (Manzate 75DF/80WP)	25		0.75-1 lb/100 gal	Tight cluster, pink, bloom, petal fall, 1st cover	5-6	77	24
mancozeb (Penncozeb 75DF/80WP)	25		0.75-1 lb/100 gal	Tight cluster, pink, bloom, petal fall, 1st cover	5-6	77	24
metiram (Polyram 80WP)	20		1 lb/100 gal	Tight cluster, pink, bloom, petal fall, 1st cover	5-6	77	24
myclobutanil (Nova 40WP)	30	Combination with contact fungicide	1.5-2 oz/100 gal	Tight cluster, pink, bloom, petal fall, 1st cover	3-5	14	24
thiram (Thiram 65WP)	2		1.5-2 lb/100 gal	Tight cluster, pink, bloom, petal fall, 1st cover	5-6	0	24
triadimefon (Bayleton 50DF)	10	Combination with contact fungicide	0.5-2 oz/100 gal	Tight cluster, pink, bloom, petal fall, 1st cover	3-5	45	12
triflumizole (Procure 50WS)	10	Combination with contact fungicide	3-4 oz/100 gal	Tight cluster, pink, bloom, petal fall, 1st cover	3-5	14	24

2. Apple Scab

Type of Pest: Fungus
Frequency of Occurrence: Annually on 100% of apple trees
Damage Caused: Scab may occur on leaves, fruit, leaf and fruit stems, and green twigs. Infections of the leaves and fruit are most common and obvious. Early season infections usually occur on the underside of the blossom cluster leaves because these are the first tissue surfaces to emerge from buds in the spring. Once the cluster leaves have unfolded and terminal leaves begin to develop, infections become evident on the upper surface of the leaves. Individual infections appear as roughly circular, brown to dark olive-green spots (lesions), which often seem slightly fuzzy or velvety in texture. Lesions along the veins or margins often cause those regions of the leaves to distort or crinkle. Primary (ascospore) infections are usually limited to one or two distinct spots per leaf, whereas secondary (conidia) infections are often much more numerous. Secondary infections occasionally are so numerous that the entire surface of the leaf appears covered with scab, a condition commonly referred to as sheet scab. Lesions on young fruit initially resemble those on leaves but turn dark brown to black and become corky or scablike with time. Cells near lesions on young fruit may be killed, causing these regions to become deformed or cracked as they fail to grow and expand along with the remainder of the apple. Primary (ascospore) infections are usually limited to one or two distinct spots per fruit, often near the blossom end because it is upturned during the early stages of fruit development. Secondary infections are frequently much more numerous and may be clumped or grown together, particularly if the fruit is directly beneath a concentrated source of secondary spores such as an infected leaf. Secondary infections that occur in late summer or early fall are often numerous and relatively small in size, a

symptom referred to as pin-point scab. Infections that occur just before harvest may be symptomless at picking yet develop into storage scab lesions after harvest.

% Acres Affected: 100%

Disease Cycle: Apple scab is caused by the fungus Venturia inaequalis, which also is capable of infecting crabapple, hawthorn, mountain ash, and firethorn. In the Northeast, the scab fungus overwinters in infected leaves that have fallen to the ground. During autumn, the fungus begins to form tiny fruiting bodies (pseudothecia) which are embedded in the leaves near the surface. Sacs (asci) filled with the primary or spring spores of the fungus (ascospores) start to develop within the pseudothecia by late winter or early spring. The ascospores continue to develop and become mature as spring progresses. A few spores are usually mature at the time of bud break (green tip), and maturity progresses slowly until about the tight cluster stage of blossom development. After this time, the percentage of mature spores begins to increase rapidly whenever temperatures are favorable for tree growth. Most ascospores have matured by the end of bloom. Mature ascospores are discharged into the air during periods of rain. In daylight, discharge usually begins within 30 minutes after the start of the rain and is largely completed within 3 to 6 hours. When rainfall begins at night, discharge is often delayed until daybreak, although significant night discharge can occur under some conditions. The number of spores discharged during any one rain is determined by both the size of the potential ascospore "crop" for the season (how many leaves were infected the previous year) and the percentage of these spores that have matured since the last discharge. Ascospore discharge usually peaks in the time from pink through bloom, and nearly all ascospores have been discharged within 1 or 2 weeks after petal fall. Ascospores are blown to nearby trees by wind currents, then germinate in a film of water on the surface of leaves and fruit. If surface wetness continues long enough at prevailing temperatures, growth from the germinated spore penetrates and infects these organs just beneath the outer cuticle. Typical lesions, each bearing tens of thousands of secondary or summer spores (conidia), appear about 9 to 17 days later depending on temperature, although long periods of low humidity can delay their development. Conidia are dispersed by splashing rain throughout the rest of the season and are capable of causing new (secondary) infections. Because numerous additional conidia are produced on each new lesion, repeated secondary infections have a snowball or epidemic effect on disease development. Incidence of infection is affected by the age of leaves and fruit; young tissues generally are most susceptible. Leaves are most susceptible 1 to 5 days after unfolding and become completely resistant from the time they finish expanding until shortly before leaf drop in the autumn. Fruit are highly susceptible until about 3 to 4 weeks after petal fall, but much longer wetting periods are required for infection to occur after this time. Precise requirements for infection of mature fruit are not known, but limited data indicate that wetting periods must last at least 48 hours for significant infection to occur immediately before harvest.

Timing of Control: On most apple varieties, fungicide sprays are required every year for control of scab. Fungicide programs can be minimized and made most efficient by designing them around weather conditions (infection periods), inoculum availability, cultivar susceptibility, and specific characteristics of the available fungicides. Season-long control of apple scab is difficult if primary infections are allowed to develop. Even moderate numbers of primary lesions can produce an extremely large population of conidia, requiring an intensive fungicide program to protect fruit throughout the summer. Conversely, good control of primary infections allows use of fungicides to be reduced or omitted during the summer, once ascospores have been depleted and fruit become less susceptible. Control of primary infections has traditionally begun at or shortly after green tip, when the first ascospores become mature. The percentage of spores that are mature at this time is low, and the actual number of mature spores may be insignificant during the early stages of bud development if very little leaf scab developed the previous year (that is, the seasonal ascospore "crop" is small). Various systems for determining when fungicide programs must begin in "clean" orchards have been developed. Apple scab fungicides control disease in different ways. Some are most effective as protectants, some when applied after an infection period, and some can suppress production of conidia from established lesions. Understanding these activities and knowing which fungicides exhibit them is important for maximizing the efficiency of a fungicide program.

Yield Losses: 100% without fungicides, about 1% with current fungicides

Regional Differences: None

Cultural Control Practices: Discing to cover old leaves with soil, where practical, may help to reduce spring infections. A fall application of dolamitic lime (after leaf drop) to increase soil pH will also help reduce inoculum the following spring. Standard apple cultivars vary widely in their susceptibility to scab, which will influence the intensity of the control program necessary for a particular variety. In the Northeast, Jersey Mac is extremely susceptible; McIntosh and its progeny (Cortland, Macoun, Empire) are highly susceptible; Rome, Red Delicious, R. I. Greening, Crispin, 20-Ounce, and Northern Spy are moderately susceptible; and Golden Delicious, IdaRed, Jonathan, and PaulaRed are moderately resistant. (Because the scab fungus has different races, these rankings are not necessarily applicable to other regions where different races may predominate.) Cultivars that are immune to apple scab are available, including some with fruit quality that appears to be commercially acceptable (e.g., Liberty, Florina, Goldrush); additional selections are being evaluated, but none of the scab-resistant cultivars have been widely accepted in the marketplace.

Biological Control Practices:

Post-Harvest Control Practices:

Other Issues: In the Northeast, it is usually not possible to produce apples commercially without some program to control this disease.

Chemical Controls for Apple Scab:

captan (Captan 50WP)	50	Cover	1 lb/100 gal	Petal fall	4-6	0	48-96
captan (Captan 4L)	50	Cover	1 qt/100 gal	Petal fall	4-6	0	48-96
mancozeb (Dithane 75DF/80WP)	30		0.75-1 lb/100 gal	Green tip ,half-inch green, tight cluster, pink, bloom, petal fall		77	24
mancozeb (Manzate 75DF/80WP)	30		0.75-1 lb/100 gal	Green tip ,half-inch green, tight cluster, pink, bloom, petal fall	5-6	77	24
mancozeb (Penncozeb 75DF/80WP)	30		0.75-1 lb/100 gal	Green tip ,half-inch green, tight cluster, pink, bloom, petal fall		77	24
dodine (Syllit 65WP)	5		6 oz/100 gal	Green tip ,half-inch green,	2	7	48
fenarimol (Rubigan 1EC)	30		3 fl oz/100 gal	Tight cluster, pink, bloom, petal fall	2-4	30	12
myclobutanil (Nova 40WP)	40		1.5-2 oz/100 gal	Tight cluster, pink, bloom, petal fall	2-4	14	24
triflumizole (Procure 50WS)	10		3-4 oz/100 gal	Tight cluster, pink, bloom, petal fall	2-4	14	24
Trifloxystrobin (Flint)	10		0.6-1 oz/100 gal	Tight cluster, pink, petal fall, 1st cover	2-3		
Kresoxim-methyl (Sovran)	10		1.3-2 oz/100 gal	Tight cluster, pink, petal fall, 1st cover	2-3		

3. Bitter Rot

Type of Pest: Fungus
Frequency of Occurrence: Sporadic, mostly in southeastern NY
Damage Caused: The disease occurs in orchard blocks beginning in July through August, however, its appearance varies with the climatic conditions during any particular season. Fruit infection can occur early in the season but symptoms do not develop until the fruit begins to mature. The rot begins as a small, light brown, circular lesion. As lesions enlarge, they change to a dark brown and form sunken or saucer-shaped depressions. The number of lesions per fruit may vary from one to many. When lesions reach about one inch (25 mm) in diameter, fruiting bodies of the fungus appear near the center of the lesion. Under humid conditions, large numbers of spores are produced in a creamy mass, salmon pink in color, which are often arranged in concentric circles. Under dry conditions, the spore mass appears crystalline. The rotted flesh beneath the surface of the lesion is watery, appearing in a V-shaped pattern in cross section that narrows toward the core. The fruit decays rapidly as it ripens and eventually shrivels into a mummy that may remain attached to the tree throughout the winter. With bitter rot, the rotten flesh is brown and more watery than would be expected with black rot. White rot lesions appear more cylindrical when the fruit is cut open. Other decays commonly seen in the orchard at this time of year are usually initiated at bird pecks or insect injuries. If decays occur on fruit where the skin has not been damaged, bitter rot is the most likely cause. Unprotected fruit exposed to high inoculum levels may develop many small dark spots which initially give the fruit a peppered appearance. A leaf spot has been associated with Glomerella cingulata (the perfect stage of Colletotrichum gloeosporioides). Spots begin as small, red flecks, which enlarge to form irregular brown spots 1/16 to 1/2 inch in diameter. Severely infected leaves may fall prematurely. Bitter rot cankers are rare in the eastern United States. When they occur, cankers are target-shaped, i.e. oval, sunken and often marked with zones or concentric rings.
% Acres Affected: 10-40%
Disease Cycle: The fungus overwinters in mummified fruit, in cracks and crevices in bark, and in cankers produced by the bitter rot fungus or by other diseases, such as fire blight. Jagged edges of broken limbs are also ideal sites. The bitter rot fungus is one of the few rot organisms that can penetrate unbroken skin of fruit. Although penetration is direct, wounds can be colonized rapidly by the fungus. Spores are waterborne and are released during rainfall throughout the growing season. Fruit infection can occur early but is more common from mid to late season. Often, the first infections appear in cone-shaped areas within the tree beneath mummies or a canker. Factors which determine the time of appearance of bitter rot are the maturity of fruit, temperature and humidity, and the presence of disease in the area. The optimum conditions for disease development include rainfall, relative humidity of 80 to 100 percent, and warm temperatures. Infection can occur in as little as five hours at 79-82°F (26°C). At 80°F, lesions can

develop and produce spores within 11 days of inoculation. Epidemics can develop rapidly during prolonged warm, wet weather, and losses can be extensive. The most severe epidemics usually occur when the early season is warm and wet and primary infection occurs early, providing abundant secondary inoculum.
Timing of Control: Fungicides, applied at appropriate intervals from petal fall through harvest, are necessary for managing the disease on susceptible cultivars
Yield Losses:
Regional Differences:
Cultural Control Practices: Removal of mummified fruit, dead wood, and twigs killed by fire blight are important sanitation measures that can reduce the incidence and severity of the disease in some years. Removing newly infected fruit from trees during the growing season may also help reduce the rate of disease spread. Apple cultivars do not vary widely in their susceptibility to the bitter rot fungi; however, the disease is often more severe on Empire, Freedom, Golden Delicious, Fuji, Granny Smith, Nittany and Arkansas Black. The use of a calcium as a nutritional supplement may reduce the incidence and severity of bitter rot in some years. In some cases, inoculum originates with shade trees adjacent to orchards and removal or fungicide treatment of shade trees can reduce inoculum in orchards.
Biological Control Practices:
Post-Harvest Control Practices:
Other Issues:

Chemical Controls for Bitter Rot:

captan (Captan 50WP)	100	Cover	1-2 lb/100 gal	Petal Fall and Cover Sprays	4-7	0	48-96

4. Black Rot/White Rot

Type of Pest: Fungus
Frequency of Occurrence: Annually
Damage Caused: Leaf symptoms first occur early in the spring when the leaves are unfolding. They appear as small, purple specks on the upper surface of the leaves that enlarge into circular lesions 1/8 to 1/4 inch (3-6 mm) in diameter. The margin of the lesions remains purple, while the center turns tan to brown. In a few weeks, secondary enlargement of these leaf spots occurs. At this time, the lesions assume a characteristic "frog-eye" appearance. As they age, a series of concentric rings develops around the original infection point. Occasionally, small black pycnidia (asexual fungus fruiting body) can be found in the center of the lesion. Heavily infected leaves become chlorotic and defoliation occurs. Fruit infection, of which sepal infection is the most common form, can occur early in the season. These infections result in blossom-end rot later in the season. Early fruit infection usually appears at the calyx end of the fruit. These lesions begin as reddish spots which later turn purple and are bordered by a red ring. Infected areas on mature fruit become black, are irregular in shape, and are occasionally surrounded by a red halo. As the rotted area enlarges, a series of concentric bands of uniform width form which alternate in color from black to brown. The flesh of the rotted area remains firm and leathery. Black pycnidia are often seen on the surface of the infected fruit. Eventually, a dry mummy is produced that may remain attached to the tree. Lesions resulting in canker formation usually are associated with a wound in the bark. In the early stages, the bark is slightly sunken and reddish-brown in color. Some cankers remain small and may die out by the end of the year, while others enlarge from year to year. Some cankers are observed to be merely a superficial roughening of the bark. In other cases, the canker can kill the bark to the wood and the area becomes cracked. By the end of the second year, fruiting bodies of the fungus can be observed in the cankered area. Limbs can be completely girdled by this time. The black rot fungus often can be found on wood previously killed by fire blight or damaged by cold temperatures.

The white rot fungus can cause superficial lesions on tree bark, and these lesions cause cankers that damage and kill limbs when trees are under drought stress.
% Acres Affected: 100% in absence of current fungicides.
Disease Cycle: The fungus overwinters in cankers, especially in those initiated by fire blight, in dead bark, and in mummified fruit. These overwintering structures provide an important source of disease inoculum. The black rot fungus covers a wide geographical range and can infect many hosts other than apple. The role these hosts play in the spread and development of the disease is not known. In the spring, spores are released during rainfall. The amount and duration of rainfall, as well as temperature, are the main factors influencing spore release, germination, and infection. Conidia are primarily waterborne and continue to be produced during wet periods throughout the summer. Ascospores are primarily airborne and are most common during the petal fall period. Ascospores and conidia germinate after four hours of wetting over a temperature range of 61 to 90° F (16-32° C). Below temperatures of 61°F (16°C), longer wetting periods are needed for infection to occur. The optimum temperature for leaf infection is 80°F (27°C). At this temperature, four and a half hours are necessary for infection. Leaf infection will not occur, however, at 46°F (80°C) even when leaves have been wet for 48 hours. For fruit infection to occur, temperatures between 68 and 75°F (20-24°C) with at least a nine hour wetting period are required. During rain, conidia ooze out by

the thousands and are disseminated by splashing rain, wind, and insects. Spores attach themselves to the plant, germinate in a film of moisture within five to six hours and penetrate the leaf surface through stomata. Early season infection of fruit also occurs through stomata. Later in the season, infection of fruit occurs through cracks in the cuticle or via wounds and possibly lenticels. Often, harvest injuries may become infected and the fruit may decay during or after storage. Throughout the growing season, infections occur through wounds in the bark or on killed wood.

Timing of Control: Fungicide applications from tight cluster through harvest may be necessary where the disease is a recurrent problem. The differences in varietal susceptibility to fruit rot are small, although Cortland and Empire may be slightly more susceptible.

Yield Losses:

Regional Differences:

Cultural Control Practices: The disease pressure can be reduced by removal of inoculum sources (dead wood and mummies).

Biological Control Practices:

Post-Harvest Control Practices:

Other Issues:

Chemical Controls for Black Rot/White Rot:

captan (Captan 50WP)	100	Cover	1-2 lb/100 gal	Petal fall and cover sprays	4-7	0	48-96
benomyl (Benlate 50WP)	30	Cover	2-3 oz/100 gal	Tight cluster, pink, petal fall, cover sprays		14	24
thiophanate-methyl (Topsin-M 70WP)	30	Cover	3-4 oz/100 gal	Tight cluster, pink, petal fall, cover		0	12
captan (Captan 4L)		Cover	1pt/100 gal	Petal fall and cover sprays	4-7	0	48-96
Trifloxystrobin (Flint)	10		0.6-1 oz/100 gal	Tight cluster, pink, petal fall, 1st cover	2-3		
Kresoxim-methyl (Sovran)	10		1.3-2 oz/100 gal	Tight cluster, pink, petal fall, 1st cover	2-3		

5. Blossom End Rot

Type of Pest: Fungus

Frequency of Occurrence: Sporadic

Damage Caused:. The infected area is seen as a small, 1/4- to 1/2-inch-diameter lesion next to or including part of the calyx. Usually brown, the spot is slightly sunken and often has a red border. A shallow, dry or corky rot develops in the flesh beneath the spot.

% Acres Affected: 5%

Disease Cycle: The disease, caused primarily by the fungus Botrytis cinerea, attacks the blossom end of apple fruit. The infection is likely to occur during bloom, although it is not visible until several weeks later.

Blossom end rot appears to be more common in seasons of prolonged cool, wet weather during and shortly after bloom. It has appeared most frequently on Delicious, Rome Beauty, and McIntosh. On stored fruit, especially Delicious, blossom end rot often leads to moldy core.

Timing of Control: Bloom and petal fall

Yield Losses:

Regional Differences:

Cultural Control Practices: The disease may be more severe in orchards with weedy ground cover because S. sclerotiorum grows on broadleaf weeds. Using 2,4-D herbicides to eliminate broadleaf weeds may help reduce disease pressure.

Biological Control Practices:

Post-Harvest Control Practices:

Other Issues:

Chemical Controls for Blossom End Rot:

benomyl (Benlate 50WP)	5		3 oz/100 gal	Bloom, petal fall	1-2	14	24

thiophanate-methyl (Topsin-M 70WP)	5		3 oz/100 gal	Bloom, petal fall	1-2	0	12
thiophanate-methyl (Topsin-M 4L)	5		4 fl oz/100 gal	Bloom, petal fall	1-2	0	12

6. Powdery Mildew

Type of Pest: Fungus
Frequency of Occurrence: Annually
Damage Caused: PM overwinters as fungal strands (mycelium) in vegetative or fruit buds which were infected the previous season. Infected terminals may have a silvery gray color, stunted growth, and a misshapen appearance and are more susceptible to winter kill than are noninfected terminals.

PM causes reduced photosynthesis in severly affected leaves. Flowers that become infected in the pink stage produce russetted fruits that have no value in the fresh market. Flower buds with primary infections are misshapen and will not produce fruit.
% Acres Affected:
Disease Cycle: Primary Infection and Spread: As buds break dormancy, the PM fungus resumes growth and colonizes developing shoots causing primary infections. The powdery white appearance on infected shoots consists of many thousands of spores (conidia) which are responsible for spreading the fungus and causing the secondary infections. Primary mildew infections may occur on vegetative shoots and blossoms and thereby cause a reduction in yield. Pruning of severely infected trees often results in poor tree structure.

Secondary Infection: Secondary infections are important because they produce the overwintering infected buds. Secondary infections usually develop on leaves and buds before they harden off and may reduce the vigor of the tree. Fruitlets may become infected shortly after bloom, resulting in a weblike russetting on the mature fruit.

Favorable Conditions for Infection: PM infections occur when the relative humidity is greater than 90% and the temperature is between 10-25° C (50-77° F). The optimum temperature range for the fungus is 19-22° C (66-72° F). Although high relative humidity is required for infection, the spores will not germinate if immersed in water. Leaf wetting is, therefore, not conducive to PM development. Under optimum conditions, PM will be obvious to the naked eye 48 hr after infection. About 5 days after infection, a new crop of spores is produced. Nongerminated powdery mildew spores can tolerate hot, dry conditions and may persist until favorable conditions for germination occur.

Temperatures near –28°C (-18° F) kill a majority of mildewed buds and the fungus within them. Even at lower temperatures, however, some PM survives. The PM fungus produces masses of small black structures called perithecia or cleistothecia on infected leaves and terminals in the late summer and fall. Although the perithecia contain spores, they do not cause infections.
Timing of Control: Where PM susceptible varieties are grown and favorable environmental conditions exist, a fungicide spray program is necessary to control the disease. The major objectives of the spray program are to: 1) reduce the number of spores produced on newly-developing infected tissues in the spring (primary mildew), 2) prevent infections of new shoots, buds, and leaves during the growing season (secondary mildew), and 3) prevent fruit infections. In general, sprays at 7-10 day intervals starting at tight cluster and continuing through petal fall are recommended. Cover sprays should also be applied until terminal buds have set and are no longer susceptible to infection. Since the fungus is infective during dry periods of high relative humidity when redistribution of fungicides by rain does not occur, spray coverage is extremely important.
Yield Losses:
Regional Differences:
Cultural Control Practices: Pruning infected buds during the dormant season has not proven to be an effective cultural practice in erradicating overwintering inoculum and is generally not used in commercial operations.
Biological Control Practices:
Post-Harvest Control Practices:
Other Issues: The cultivars Baldwin, Cortland, Ginger Gold, Braeburn, Idared, Jonathan, Monroe, and Rome are particularly susceptible to PM. Other cultivars may also become infected when inoculum is present and conditions are favorable for infection.

Chemical Controls for Powdery Mildew:

fenarimol (Rubigan 1EC)	20		3 fl oz/100 gal		3-5	30	12
sulfur (Sulfur 95WP)	30		2 lb/100 gal		3-6	0	24
sulfur (Sulfur 6F)	10		2 pt/100 gal		3-6	0	24

triadimefon (Bayleton 50DF)	10		1-2 oz/100 gal		2-4	45	12
myclobutanil (Nova 40WP)	30		1.5-2 oz/100 gal		3-5	14	24
triflumizole (Procure 50WS)	10		2-4 oz/100 gal		3-5	14	24
oil (JMS Stylet Oil)	1		1-2% solution		6-8		12
Trifloxystrobin (Flint)	10		0.6-1 oz/100 gal	Tight cluster, pink, petal fall, 1st cover	2-3		
Kresoxim-methyl (Sovran)	10		1.3-2 oz/100 gal	Tight cluster, pink, petal fall, 1st cover	2-3		

7. Sooty Blotch and Fly Speck

Type of Pest: Fungus
Frequency of Occurrence: Disease incidence and severity can be highly variable among production regions, growing seasons, and individual orchards.
Damage Caused: Sooty blotch appears as dark olive green or sooty-colored fungus colonies on the surface of infected fruit. One to many nearly circular colonies may develop individually or large, unshaped colonies may spread out over the fruit. Symptoms can develop as soon as 3-4 weeks after petal fall, but are usually much more common and severe by late summer or early fall.
% Acres Affected: 100% in absence or currently registered fungicides.
Disease Cycle: Sooty blotch can be caused by three different fungi. Flyspeck is the more important disease organism in New York. The fungi overwinter as fruiting bodies (pycnidia) or in a vegetative state (mycelium) on infected twigs of apple trees and numerous woody plants in hedgerows and woodlots; these "reservoir hosts" include brambles (blackberries and raspberries), oaks, maples, ash, elm, grape, tulip tree, and many others common to eastern North America. Spores formed within the pycnidia or from sections of the mycelium are spread by rains during the late spring and early summer, and begin causing fruit infections about 2-3 weeks after petal fall. Typical sooty blotch symptoms are caused by the dark mycelium of fungal colonies that develop on the surface of the fruit cuticle. Because of the superficial nature of this growth, it is extremely sensitive to the microclimate conditions (particularly relative humidity) immediately surrounding the fruit. Growth is optimum at 100 percent relative humidity; good at 95, fair at 92, poor at 90 percent; no growth occurs below 90 percent relative humidity. The effects of temperature vary somewhat among individual isolates, but optimum temperatures are generally about 64-80° F (18-27° C); growth is very limited and slow during periods below 50° F (10° C) or above 86° F (30° C). The period of time between the beginning of an infection and the appearance of symptoms depends on how often and for how long temperature and humidity conditions allow fungal growth. In the Northeast, this incubation period is often 3-4 weeks under relatively favorable conditions, but can be 2 months or longer otherwise. In warmer regions where the disease occurs regularly (e.g., the Hudson Valley), it is common for infections to be initiated during the early cover spray period, stop development during a hot and dry mid-summer, then finish incubating and finally become apparent when conditions become more favorable towards the end of summer. Once fungal colonies do appear, mycelial fragments can be broken off by raindrops and spread to additional fruit, causing further disease if environmental conditions remain favorable. Thus, disease is generally most severe in years and orchards where conditions favor early disease development followed by extensive secondary spread. Sooty blotch infections that are not apparent at harvest can sometimes finish their development during long periods of cold storage when relative humidities are near 100 percent.
Timing of Control: The need for and timing of fungicide sprays to control these diseases is variable among orchards and years. In regions where they occur regularly, sprays should start around first cover and be repeated as necessary according to the prevailing weather conditions and material being used. Where the diseases occur more sporadically, fungicide programs should be initiated and continued on the basis of weather conditions, specific orchard factors, and previous experience.
Yield Losses: 0.5-1% of crop
Regional Differences: More severe in southeastern part fo the state where relative humidity is higher in summer.
Cultural Control Practices: Annual pruning to open tree canopies and promote air circulation will minimize the periods favorable for their development. Supplemental summer pruning in dense-canopied trees can provide significant additional benefits in some years. Proper fruit thinning is also important for reducing the development of high-humidity microclimates around clustered fruit; like good pruning, thinning will furthermore improve the spray coverage for any fungicides that may be applied. Mowing of grass middles and good within-row weed control will provide additional help in reducing overall humidity levels within orchards during the summer. The removal of hedgerows or surrounding woodlots is not always practical, but can substantially improve airflow and reduce humidities within the orchard. Destruction of the many woody reservoir hosts in these sites will also reduce some of the inoculum that initiates fruit infections. Because of their importance as an inoculum source, it is particularly important to eliminate brambles in hedgerows and within the orchard itself should they occur there.

Biological Control Practices: None
Post-Harvest Control Practices:
Other Issues:

Chemical Controls for Sooty Blotch and Fly Speck:

*benomyl** *(Benlate 50WP)*	30		2-3 oz/100 gal	July-August sprays	3-5	14	24
thiophanate-methyl (Topsin-M 70WP)	60		3-4 oz/100 gal	June-July-August	4-6	0	12
captan (Captan 50WP)	100		1 lb/100 gal		4-7	0	48-96
captan (Captan 4L)	100		1 pt/100 gal		4-7	0	48-96
mancozeb (Dithane 75DF/80WP)	80		0.75-1 lb/100 gal	Petal fall, 1st cover, 2nd cover	3	77	24
mancozeb (Manzate 75DF/80WP)	80		0.75-1 lb/100 gal	Petal fall, 1st cover, 2nd cover	3	77	24
mancozeb (Penncozeb 75DF/80WP)	80		0.75-1 lb/100 gal	Petal fall, 1st cover, 2nd cover	3	77	24
metiram (Polyram 80WP)	10		0.75-1 lb/100 gal	Petal fall, 1st cover, 2nd cover	3	77	24
*ziram** (Ziram 76DF)*	30		1 lb/100 gal	July-August	2-4	14	48
Trifloxystrobin (Flint)	2	Cover	0. 75oz/100 gal	Summer	1-2		
Kresoxim-methyl (Sovran)	2	Cover	1.5 oz/100 gal	Summer	1-2		

*Benomyl applied within 45 days of petal fall may cause scarf skin, a physiological fruit finish problem.
**Used primarily as a substitute for captan when growers wish to avoid the 4-day re-entry with captan or when they apply oil with summer sprays.

8. Blister Spot

Type of Pest: Bacterial
Frequency of Occurrence: Annually in 50% of Mutsu blocks.
Damage Caused: This bacterial disease is of economic importance mainly on the cultivar Mutsu (Crispin) but can be seen on Golden Delicious and Fuji when grown adjacent to Mutsu. Even though fruit grow to maturity and no detectable yield loss occurs, severe infection results in ugly fruit and greatly reduces fresh market quality. Infections of blister spot are first noticeable two to three months after petal fall as small, green, water-soaked, raised blisters that develop at fruit stomata. These spots result in purplish black lesions associated with fruit lenticels. As the fruit increase in size, the lesions expand to about 3/16 inch (5 mm) and become darkened. A mid-vein necrosis of Mutsu apple leaves has been observed prior to fruit lesion development. Under severe conditions, the bacteria can kill fruit spurs.
% Acres Affected:
Disease Cycle: The bacterium overwinters in a high percentage of apple buds, leaf scars, and diseased fruit on the orchard floor. Throughout the growing season, the bacterium can survive as an epiphyte on foliage and fruit in the orchard. Even though the highest populations of the pathogen have been found on Mutsu, the bacterium has also been detected on foliage and fruit of other apple cultivars. Young Mutsu fruit show an increased susceptibility to infection for about six weeks, beginning about two weeks after petal fall.
Timing of Control: Earliest spots can be detected near the calyx end of the fruit that face the sun and are on the periphery of the tree, beginning about mid- to late July.
Yield Losses:
Regional Differences:
Cultural Control Practices:
Biological Control Practices:
Post-Harvest Control Practices:
Other Issues: The disease is mainly a problem on the apple cultivar Mutsu. When Mutsu is interplanted with other (normally) resistant apple cultivars (i.e. Red Delicious, Cortland, and others), the pathogen may spread into these,

also. Prior to the development of streptomycin-resistant strains of the pathogen, the disease could be controlled with three well-timed antibiotic sprays, the first applied no later than 2 weeks after petal fall, and the others applied weekly thereafter. This strategy is still employed in orchards without resistant strains; however, resistant strains may develop after only a few years of antibiotic use. Once resistance to the antibiotic develops, further use of antibiotic is ineffective.

Chemical Controls for Blister Spot:

Streptomycin (Agristrep 17WP)	3		0.5 lb/100 gal	1st, 2nd, and 3rd covers	2-3	50	12

9. Fire Blight

Type of Pest: Bacterial

Frequency of Occurrence: Outbreaks are sporadic in most parts of the Northeast, but can cause extensive tree damage when they do occur.

Damage Caused: Fire blight produces several different types of symptoms, depending on what plant parts are attacked and when. The first symptom to appear, shortly after bloom, is that of blossom blight. In the early stages of infection, blossoms appear watersoaked and gray-green but quickly turn brown or black; generally, the entire cluster becomes blighted and killed. The most obvious symptom of the disease is the shoot blight phase, which first appears one to several weeks after petal fall. The leaves and stem on young, succulent shoot tips turn brown or black and bend over into a characteristic shape similar to the top of a shepherd's crook or candy cane. Small droplets of sticky bacterial ooze often can be seen on the surface of these blighted shoots when the weather is warm and humid. Under favorable conditions, shoot blight infections will multiply and continue to expand down the stems, causing the tree to appear scorched by fire. Shoot blight infections can expand beyond the current season's growth into the older supporting wood, causing dark sunken cankers to form. Fruit may appear small, dark, and shriveled if infected when young, or show expanding red, brown, or black lesions when infected later. Infected fruit often exude droplets of sticky bacterial ooze, particularly when the weather is warm and humid. Entire trees on highly susceptible rootstocks (Mark, M. 9, M. 26) or interstems can wilt and die if this portion becomes infected. The original source of such "rootstock blight" infections is not always obvious.

% Acres Affected: 15% annually

Disease Cycle: Fire blight bacteria overwinter in the bark at the edge of cankers formed during previous growing seasons. As weather becomes warm in the spring, the bacteria multiply, ooze to the surface in sticky droplets, and are transferred to flowers by insects or rain. Once on the flower stigmas (sticky pollen receptors), the bacteria multiply rapidly when temperatures are greater than 65° F (18° C), and are easily moved from flower to flower by bees. Bacteria on the stigmas can build to very high levels during warm bloom periods, but infection does not usually occur unless they are washed by rain to natural openings (nectaries) at the flower base. Blossoms wilt and die about 1-2 weeks after infection occurs, and the bacteria that ooze from them provide inoculum for secondary spread to young succulent shoots. The bacteria are moved to shoots by insects and rain, and infection occurs through wounds caused by insect feeding, wind-whipping, and hail. Additional bacterial ooze is produced from these new infection sites, providing inoculum for further spread so long as shoots keep growing and wounds are produced. As the season advances, shoots become progressively less susceptible to new infections as their growth slows and stops. Bacterial advancement through woody tissues also slows and cankers are formed, where some bacteria overwinter and renew the disease cycle the following spring. In addition to producing surface ooze in the spring, overwintering bacteria occasionally move internally from canker margins to nearby shoots, which they infect systemically. Such "canker blight" infections produce a characteristic yellow-orange color in the wilting shoot tips during the early postbloom period. These infection sites can provide an alternative source of inoculum or initiating summer shoot blight epidemics in years when blossom blight is scarce. Rootstock infections can occur as a specialized form of shoot blight and canker formation, when succulent rootstock suckers become blighted and infection progresses into the rootstock portion of the trunk. However, most rootstock infections are not associated with suckers, and it appears that many develop when bacteria move systemically from scion infections down into the rootstock. The factors that influence this systemic movement are unknown.

Timing of Control: Fire blight is best controlled using an integrated approach that combines (a) horticultural practices designed to minimize tree susceptibility and disease spread; (b) efforts to reduce the amount of inoculum in the orchard; and (c) well-timed sprays of bactericides to protect against infection under specific sets of conditions.

Yield Losses:

Regional Differences:

Cultural Control Practices: Horticultural practices. The most effective horticultural practice for minimizing fire blight outbreaks is to avoid highly susceptible cultivars and rootstocks. Highly susceptible apple cultivars include Crispin (Mutsu), Fuji, Gala, Ginger Gold, Idared, Jonathan, Monroe, Paulared, Rhode Island Greening, Rome Beauty, 20 Ounce, and Wayne. Such cultivars on highly susceptible rootstocks (Mark, M.9, M.26) are particularly dangerous combinations, since one bad outbreak can lead to substantial tree death within the orchard. Shoot blight is most common on young succulent growth therefore, pruning systems and nitrogen fertilization practices that avoid excessive and prolonged shoot growth are important for limiting shoot blight severity. Advancement of disease into the supporting framework of the tree can be minimized by pruning out blighted shoots as soon as they appear in the early summer. This practice is particularly important on young or dwarf trees, where infected shoots may be only a short distance from the trunk or major scaffold limbs. Cuts should be made at least 8-12 inches (20-30 cm) below the margin of visible infection. Sterilizing pruning shears with alcohol or household bleach between each cut is commonly recommended, although this practice is often impractical and of limited value. Good control of leafhoppers and pear psylla can be important to slow the spread of shoot blight infections.

Inoculum reduction. Primary inoculum sources should be reduced by pruning out cankered limbs and branches during the dormant season. Application of a copper-containing fungicide/bactericide at or shortly after green tip will further reduce the number of new fire blight bacteria produced from overwintering cankers. In orchards with a history of fire blight, the yelloworange shoots characteristic of canker blight infections should be scouted for and pruned out 1-2 weeks after petal fall; this is particularly useful when blossom blight is well-controlled and canker blight infections are the main source of inoculum for disease spread during the summer. Pruning out new shoot blight infections as they appear can also help limit disease spread, but will be most effective if practiced rigorously during the first few weeks after bloom; pruning will do little to slow disease spread if delayed until a large number of infections are visible.

Biological Control Practices: None

Post-Harvest Control Practices: Primary inoculum sources should be reduced by pruning out cankered limbs and branches during the dormant season.

Other Issues:

Chemical Controls for Fire Blight:

[redacted]							
copper hydroxide (Kocide)	20	Full cover spray	2-4 lbs/100 gal	Dormant to bud swell	1	PB	48
copper hydroxide (Champ Flowable)	20		1-2 qt/100 gal	Dormant to bud swell	1	PB	48
copper oxychloride (C-O-C-S)	20	Full cover spray	2-4 lbs/100 gal	Dormant to bud swell	1	PB	24
Bordeaux mixture (copper sulfate, spray lime + spray oil)(8-8-100)	20	Cover spray	(copper sulfate 8 lbs, spray lime 8 lbs+ spray oil 1 qt)/100 gal	Dormant to bud swell	1		
stretomycin (Agristrep 17 WP)	15	Full cover spray	0.25-0.5 lb/100 gal	Spray at 20-30% bloom	1.5	50	12

PB=Prebloom

10. Phytophthora root and crown rot

Type of Pest: Fungal

Frequency of Occurrence:

Damage Caused: Diseased trees are most likely to be found in heavy, wet soils or sections of the orchard where water collects or is slow to drain. Symptoms visible above ground vary among tree species and locations but include poor growth with sparse, off-color foliage, wilt, and collapse. Infected trees may decline over more than one season, and gradually declining apple trees in particular may show a purple discoloration in the autumn. In other cases, previously healthy trees may suddenly collapse and die shortly after resuming growth in the spring, often following an excessively wet autumn; or previously healthy trees may suddenly collapse during the latter part of the growing season, often following an excessively wet spring. A diagnostic reddish-brown discoloration of inner bark can be seen by removing several inches of soil around the base of declining trees and cutting away the outer bark layer on the exposed crowns. The inner bark of infected roots may show a similar discoloration. This symptom distinguishes Phytophthora root and crown rots from other causes of decline and collapse.

% Acres Affected:

Pest Life Cycles: Phytophthora root and crown rots are caused by a group of related soilborne fungi in the genus Phytophthora. Some of these fungi are common inhabitants of agricultural soils, whereas others are introduced on contaminated planting stock or through the movement of contaminated soil and water. Although the individual Phytophthora species vary somewhat in origin, particular biological characteristics, and destructiveness against different crops and rootstocks, all have one critical trait in common: they are capable of causing significant damage only when soils are extremely wet or saturated. The Phytophthora fungi persist in the soil mainly as dormant resting spores (oospores, chlamydospores) or in a vegetative growing form within infected plant tissue. When the soil is moist or wet, reproductive structures (sporangia) are produced, either as the result of germinating resting spores or as direct outgrowths of the active fungus within infected roots and crowns. These sporangia are filled with the infective spores of the fungus (zoospores), which are expelled into the soil in significant numbers only when it is completely saturated with water - that is, when water is standing or puddled on the soil surface. The microscopic zoospores then use tail-like structures to swim short distances through the water-filled soil pores and find susceptible plant tissues, to which they are chemically attracted. Zoospores may also swim to the soil surface, where they can be carried relatively long distances by runoff water and contaminate new soils or ponds and canals used for irrigation water. Whether infection occurs once zoospores reach root or crown tissues depends largely on the inherent susceptibility of the rootstock and its physiological condition. Although many of the physiological factors that influence disease development are unknown, it appears that a tree's ability to resist infection is reduced when saturated soil conditions deprive its roots of oxygen. Therefore, episodes of soil saturation serve as infection periods for Phytophthora root and crown rots because they not only provide the conditions necessary for zoospore activity but also increase the tree's susceptibility to disease during that time. The minimum length of the saturated period necessary to produce an infection can be highly variable, depending on a wide variety of genetic, physiological, and environmental factors; however, the severity of the infection period is roughly proportional to the number of days the soil remains saturated and how quickly it drains thereafter. The number of saturation periods a tree is exposed to is also important because additional zoospores are produced and released by the fungus growing in new infection sites each time conditions become favorable. Some rootstocks appear to be most susceptible to infection during the spring and autumn, which are also the periods of the year when soil temperatures are most favorable for zoospore production and activity. Rootstock susceptibility and fungus activity are both low in the winter while trees are dormant.

Timing of Control: New fungicides have recently been developed which are effective in controlling these diseases when used preventively, but they are seldom effective in reviving trees once the crown has become infected and moderate symptoms of decline have appeared. Fungicides are most effective when used in combination with cultural practices.

Yield Losses:

Regional Differences:

Cultural Control Practices: Control of Phytophthora root and crown rots is most successful using an integrated program of cultural practices and, sometimes, chemical control. Soils that are excessively slow to drain or subject to periodic flooding should be avoided. Marginal sites should be modified (install drain tiles, create diversion ditches, rip underlying pan layers) to provide the additional drainage recommended for growing tree fruit crops. Planting trees on ridges or berms will raise their crowns above the primary zone of zoospore activity and provide an important margin of safety, especially in a wet year. Tree species and rootstocks should be selected to match the soil and drainage characteristics of an orchard. Apple rootstocks vary widely in susceptibility but are generally more susceptible than pears and more resistant than stone fruits other than plums. Among apple rootstocks, seedlings are relatively resistant, as are M. 9, M. 2, and M. 4; M. 7, M. 26, and MM. 111 are moderately susceptible; MM. 106 is susceptible; and NIM. 104 is very susceptible.

Biological Control Practices:

Post-Harvest Control Practices:

Other Issues:

Chemical Controls for Phytophthora root and crown rot:

fosetyl-Al (Aliette 80 WP)	1		4 lbs/A		2	14	12
metalaxyl (Ridomil Gold)	2		1 qt/100 gal solution	Prebloom or post harvest	1		12

V. Pest Information: Weeds

Weeds such as deep-rooted perennials compete for soil moisture and nutrients in newly planted and mature orchard crops, while light can become limiting in newly planted crops. Weeds may host pests including plant viruses and can compete for pollinating bees in spring.

Excessive weedy vegetation in most orchards is controlled by mowing or flailing row middles and application of herbicides within the rows. Repeated use of the same or similar weed control practice results in a weed shift to species that tolerate these practices. Therefore, weeds that survive cultivation, mowing or flailing, specific herbicide treatments or other routine cultural practices must be eliminated before the tolerant species or biotypes become established. A combination of weed control practices or treatments, rotation practices and herbicides are utilized to prevent weed shifts.

Cultural Controls: Native or planted grasses in many orchards often are managed in row middles by mowing or flailing. Sods reduce soil erosion, improve traffic conditions in wet weather, and increase water infiltration and drainage.

Chemical Controls: Persistent, soil active herbicides are applied during the winter dormant season and activated with rain or sprinkler irrigation if dry conditions persist. Existing vegetation is controlled by mixing postemergence contact or translocated herbicide. In New York, ninety percent of growers are using contact herbicides. Ninety percent of those growers using them are tank mixing with residual materials for better control. Twenty percent of growers are using phenoxy acetic herbicides.

1. Annual grasses

Chemical Controls:

oxyfluorfen (Goal 1.6E)	<1	Foliar	1.2-2.0 lb/A	Dormant. Apply as soon as soil has settled and no cracks are present.	1.5-2	0	24
napropamide (Devrinol 50WP)	<1	Surface	4 lb/A	Apply as soon as soil has settled and no cracks are present.	1.5-2	35	12
pendimethalin (Prowl 4E)	25	Banded, Foliar	4 lb/A	Apply as soon as soil has settled and no cracks are present. Non-bearing trees only.	1.5-2	365	12
oryzalin (Surflan AS)	<1	Banded	3-6 lb/A	Apply as soon as soil has settled and no cracks are present.	1.5-2	0	12
paraquat (Gromoxone Extra)	25	Banded, Foliar	0.625-0.9375 lb/A	Apply to emerged weeds as needed	1.5-2	0	48
glyphosate (Roundup)	25	Banded, Drench, Foliar, Spot	1-3 lb/A	Apply to emerged weeds as needed	1.5-2	14	12
fluazifop (Fusilade 2000)	<1	Banded, Foliar, Spot	0.25-0.375 lb/A	Apply when grass is 2-8 inches tall. Repeat in 2-3 weeks.	1.5-2	365	12
sethoxydim (Poast)	<1	Band, Broadcast, Spot	0.28-0.47 lb/A	Apply to actively growing grass before tillering or seedhead formation.	1.5-2	14	12
simazine (Princep 4L, 80WP)	25	Banded, Drench, Foliar	1-2 lb/A	Apply early spring before weeds emerge.	1.5-2	0	12
simazine (Caliber 90WDG)	25	Banded, Drench, Foliar	1-2 lb/A	Apply early spring before weeds emerge	1.5-2	0	12
norflurazon (Solicam 80DF)	<1	Banded	2.0-2.4 lb/A	Apply early spring before weeds emerge.	1.5-2	0	12
diuron (Karmex 80DF)	<1	Banded, Foliar	1-2 lb/A	Apply early spring before weeds emerge	1.5-2	0	
diclobenil (Casoron 4G/50W)	<1	Broadcast	4-6 lb/A	November to March when soil temp. is below 45° F.	1.5-2	0	12

2. Broadleaf weeds

Chemical Controls:

oxyfluorfen (Goal 1.6E)	<1	Foliar	1.2-2.0 lb/A	Dormant. Apply as soon as soil has settled and no cracks are present.	1.5-2	0	24
napropamide (Devrinol 50WP)	<1	Surface	4 lb/A	Apply as soon as soil has settled and no cracks are present.	1.5-2	35	12
pendimethalin (Prowl 4E)	25	Banded, Foliar	4 lb/A	Apply as soon as soil has settled and no cracks are present. Non-bearing trees only.	1.5-2	365	12
oryzalin (Surflan AS)	<1	Banded	3-6 lb/A	Apply as soon as soil has settled and no cracks are present.	1.5-2	0	12
paraquat (Gromoxone Extra)	25	Banded, Foliar	0.625-0.9375 lb/A	Apply to emerged weeds as needed.	1.5-2	0	48
glyphosate (Roundup)	25	Banded, Drench, Foliar, Spot	1-3 lb/A	Apply to emerged weeds as needed.	1.5-2	14	12
simazine (Princep 4L, 80WP)	25	Banded, Drench, Foliar	1-2 lb/A	Apply early spring before weeds emerge.	1.5-2	0	12
simazine (Caliber 90WDG)	25	Banded, Drench, Foliar	1-2 lb/A	Apply early spring before weeds emerge.	1.5-2	0	12
norflurazone (Solicam 80DF)	<1	Banded	2.0-2.4 lb/A	Apply early spring before weeds emerge.	1.5-2	0	12
diuron (Karmex 80DF)	<1	Banded, Foliar	1-2 lb/A	Apply early spring before weeds emerge.	1.5-2	0	
dichlobenil (Casoron 4G/50W)	<1	Broadcast	4-6 lb/A	November to March when soil temp. is below 45° F.	1.5-2	0	12
2,4-D (Weedar 64)	1	Banded, Foliar, Spot	1.4 lb/A	Treat when weeds are small and actively growing	2	40	48

3. Perennial grasses

Chemical Controls:

fluazifop (Fusilade 2000)	<1	Banded, Foliar, Spot	0.25-0.375 lb/A	Apply when grass is 2-8 inches tall. Repeat in 2-3 weeks.	1.5-2	365	12
sethoxydim (Poast)	<1	Band, Broadcast, Spot	0.28-0.47 lb/A	Apply to actively growing grass before tillering or seedhead formation.	1.5-2	14	12
pronamide (Kerb 50WP)	<1	Foliar	2-4 lb/A	Apply late fall before soil freezes.	1.5-2	0	12
glyphosate (Roundup)	90	Banded, Drench, Foliar, Spot	2-4 lb/A	Varies with weed type.	1.5-2	14	12
2,4-D (Weedar 64)	10	Banded, Foliar, Spot	0.95-1.425 lb/A	Varies with weed type.	2	40	48

4. Woody brush and vines

Chemical Controls:

glyphosate (Roundup)	90	Banded, Drench, Foliar, Spot	2-4 lb/A	Varies with weed type.	1.5-2	14	12
2,4-D (Weedar 64)	10	Banded, Foliar, Spot	0.95-1.425 lb/A	Varies with weed type.	2	40	48

VI. Pest Information: Vertebrates

Two species of voles cause injury to Northeast orchards, the meadow vole and the pine vole. Determining which vole is present is very important since the treatment for each is different. By trapping some voles it is easy to tell the difference between the two. The pine vole has an extremely short tail, about the length of their back foot. Meadow voles have a slightly longer tail about twice the size of the back foot. The meadow vole lives primarily above ground, doing most of its damage in the winter as they chew on bark. Hardware cloth trunk guards embedded in the ground and extending upwards higher than snow level are usually effective. Baiting is also effective but can harm domestic pets and other wildlife. Zinc phosphide on steam-rolled oats is the best bait. Broadcast baiting is most effective against meadow voles right after mowing and before a stretch of sunny weather, hopefully knocking the population down before winter. Hand baiting bait stations in predetermined areas is also effective. Pine voles spend most of their time underground but will go above ground if there is enough cover. They feed on bark below the soil line. One technique for baiting for pine voles involves using a mechanical trail builder that lays the poison 2-4 inches underground in artificial trails.

VII. State Contacts:

Dr. Arthur Agnello
Associate Professor -- Entomology
Cornell University
Department of Entomology
New York State Ag. Experiment Station
Geneva, NY
315-787-2341
ama4@cornell.edu

Dr. Wayne Wilcox
Professor - Plant Pathology
Cornell University
New York State Ag. Experiment Station
Geneva, NY
315-787-2335
wfw1@cornell.edu

Dr. David Rosenberger
Professor – Plant Pathology
Cornell University
Hudson Valley Lab
Highland, NY 12528
914-691-7231
dar22@cornell.edu

Dr. Richard Straub
Professor -- Entomology
Cornell University
Hudson Valley Lab
Highland, NY 12528
914-691-6516
rws9@cornell.edu

Dr. W. Harvey Reissig
Professor -- Entomology
Cornell University
Department of Entomology
New York State Ag. Experiment Station
Geneva, NY
315-787-2336
whr1@cornell.edu

Dr. Deborah I. Breth
Area Extension Educator
Cornell University
PO Box 150
20 S. Main St.
Albion, NY 14411
716-589-5561
dib1@cornell.edu

Dr. Ian Merwin
Associate Professor -- Pomology
Cornell University
Department of Fruit and Vegetable Science
134A Plant Science Bldg.
Ithaca, NY 14853
607-255-1777
im13@cornell.edu

Mr. Paul Curtis
Extension Wildlife Specialist
Cornell University
Department of Natural Resources
114 Fernow Hall
Ithaca, NY
607-255-2835
pdc1@cornell.edu

Mr. Richard Reisinger
Cornell Orchard Manager
134A Plant Science
Ithaca, NY 14853
607-255-4543/4542
rdr3@cornell.edu

IX. References

1. 1999 Pest Management Recommendations for Commercial Tree-Fruit Production. 1998. Cornell Cooperative Extension, Cornell University, Ithaca, NY. 196 pp.

2. Fruit Fact Sheets. Codling Moth. Agnello, Arthur M. and David P. Kain. Department of Entomology, NYS Agricultural Experiment Station, Geneva, NYS College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

3. Fruit Fact Sheets. Obliquebanded Leafroller. Reissig, W. H. NYS Agricultural Experiment Station, Geneva, NYS College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

4. Fruit Fact Sheets. Plum Curculio. Lienk, S. E. NYS Agricultural Experiment Station, Geneva, NYS College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

5. Fruit Fact Sheets. Redbanded Leafroller. Spangler, S. and A. Agnello. Department of Entomology, NYS Agricultural Experiment Station, Geneva, NYS College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

6. Fruit Fact Sheets. Sooty Blotch. Wilcox, Wayne F. Department of Plant Pathology, NYS Agricultural Experiment Station, Geneva, NYS College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

7. Fruit Fact Sheets. Tarnished Plant Bug. Spangler, Steve M., Richard W. Weires, Jr., and Arthur M. Agnello. Department of Entomology, NYS Integrated Pest Management Program, NYS Agricultural Experiment Station, Geneva, Cornell College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

8. Fruit IPM Fact Sheet. Apple Rust Mite. Howitt, Angus H. Michigan State University Extension Service, Van Buren County, MI.

9. Fruit Fact Sheets. Fire Blight. Wilcox, Wayne F. Department of Plant Pathology, NYS Agricultural Experiment Station at Geneva, Cornell IPM Program.

10. Mid-Atlantic Orchard Monitoring Guide. Hull, L. A., D. G. Pfeiffer and D. J. Biddinger. NRAES, 152 Riley-Robb Hall, Ithaca, NY.

11. New York Agricultural Statistics.1998-1999. New York Agricultural Statistics Service, New York State Department of Agriculture and Markets, Albany, NY. 104 pp.

12. Pest and Pesticide Use Assessment for Apple and Pear Production Systems in New York State for 1995. 1996. Weingart, D., C. Coffman, W.G. Smith, and D.A. Rutz. Pesticide Management Education Program, Cornell University, Ithaca, NY. 87 pp.

13. Scaffolds Fruit Journal: Update on Pest Management and Crop Development. Department of Entomology, NYSAES, Barton Laboratory, Cornell University, Geneva, NY.

14. Scaffolds Fruit Journal: Update on Pest Management and Crop Development. September 18, 1995. Eds. Agnello, A. and D. Kain. New York State Agricultrual Experiment Station at Geneva and Cornell Cooperative Extension, Cornell University.

15. Scaffolds Fruit Journal: Update on Pest Management and Crop Development. June 19, 1995. Eds. Agnello, A. and D. Kain. New York State Agricultrual Experiment Station at Geneva and Cornell Cooperative Extension, Cornell University.

16. Scaffolds Fruit Journal: Update on Pest Management and Crop Development. April 12, 1999. Eds. Agnello, A. and D. Kain. New York State Agricultrual Experiment Station at Geneva and Cornell Cooperative Extension, Cornell University.

17. Tree Fruit IPM Insect Identification Sheet No. 10 (European Red Mite). 1980. Lienk, S. E. NYS Agricultural Experiment Station, Geneva, Cornell College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

18. Tree Fruit IPM Insect Identification Sheet No. 22 (Comstock Mealybug). 1991. Spangler, Steve M. and Arthur Agnello. Department of Entomology, NYS Agricultural Experiment Station, Geneva, Cornell College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

19. Crop Profile for Apples in Rhode Island. Pest Identifications. University of Rhode Island.

20. Michigan Apple Crop Profile Draft. Pest Identifications. Michigan State Univeristy.

21. West Virginia Apple Profile. Pest Identifications. West Virginia University.

22. North Carolina Apple Profile. Pest Identifications. North Carolina State University.

23. 1998-1999 New England Apple Pest Management Guide. Koehler, G. L., Los, D. Cooley, H. Faubert, L. Berkett and W. Machardy. Apple Information Manager (AIM). (http://orchard.uvm.edu/AIM/9697neapmg/)

24. Food and Feed Crops of the United States. Second Edition, Revised. 1998. Markle, G.M., J.J. Baron, and B.A. Schneider. Rutgers University. 517 pp.

25. NYS Pesticide Product, Ingredient and Manufacturer System. 1999. Cornell Pesticide Management Education Program. Ithaca, NY 14853.

26. US EPA Worker Protection Standard Product Safety Data Pocket Guide. 1995.

27. Blossom End Rot. Tree Fruit Pages, Horticulture Department, Penn State University, University Park, PA. (http://www.cas.psu.edu/docs/casdept/hort/tfpg/part2/part22j.htm).

28. Fruit IPM Fact Sheet. Powdery Mildew of Apple. Burr, T.J., R.C. Pearson, J.D. Gilpatrick, and M. Szkolnik Department of Entomology, NYS Integrated Pest Management Program, NYS Agricultural Experiment Station, Geneva, Cornell College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

29. Fruit IPM Fact Sheet. Woolly Apple Aphid. Seamen, A.J. and H. Riedl. Department of Entomology, NYS Integrated Pest Management Program, NYS Agricultural Experiment Station, Geneva, Cornell College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

30. Fruit Fact Sheets. Apple Scab. Wilcox, Wayne F. Department of Plant Pathology, NYS Agricultural Experiment Station at Geneva, Cornell IPM Program.

31. Tree Fruit Fact Sheet 102GFSTF-11 7 1988. Oriental Fruit Moth. Seamen, A.J. and H. Riedl. Department of Entomology, NYS Integrated Pest Management Program, NYS Agricultural Experiment Station, Geneva, Cornell College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

6/19/00